A Participant-Funded Mechanism for Distribution Markets with Integrated Tokenomics

1. Introduction

1.1. The Promise and Challenge of Distribution Markets

The aggregation of dispersed information stands as a cornerstone of efficient resource allocation and decision-making in complex systems. Financial markets, as highlighted by Hayek, serve as powerful mechanisms for this aggregation, translating individual beliefs and knowledge into collective price signals.[1] Prediction markets represent a specialized application of this principle, designed explicitly to elicit and synthesize forecasts about future events.[1] Historically, these markets have primarily focused on binary ("Yes/No") or discrete outcomes, such as election results or the achievement of specific project milestones.[2]

However, many real-world phenomena of interest exhibit continuous or high-dimensional outcomes – economic indicators, climate variables, model parameters, project completion times, and more.[4] Traditional prediction market structures struggle to capture the nuances of beliefs across such continuous spectra. The emergence of "distribution markets" aims to address this limitation, offering platforms where participants can trade contracts representing their beliefs about the entire probability distribution of a continuous outcome variable.[6] These markets promise a richer form of information aggregation, moving beyond simple point estimates or binary probabilities to capture collective uncertainty, consensus, and potential multimodality in beliefs.[7]

Paradigm's recent proposal for distribution markets, leveraging a constant function Automated Market Maker (AMM) operating over functions, represents a significant conceptual advance in this domain.[6] By allowing traders to directly manipulate and trade "outcome function tokens" – functions representing payout claims across the continuous outcome space – their model provides a framework for expressing and aggregating complex distributional beliefs.[6] This innovation has spurred considerable interest in the potential for more expressive and informationally rich market mechanisms within decentralized finance (DeFi) and beyond.

1.2. Limitations of Existing Models: The 'b' Parameter Problem

Despite its novelty, Paradigm's proposed distribution market mechanism exhibits certain limitations, primarily stemming from its reliance on a crucial parameter, 'b'.[6] This parameter represents the initial backing collateral, typically denominated in

dollars or another reserve asset, provided by the market's first liquidity provider (LP).[6] The AMM's holdings are defined relative to this backing, ($h(x) = b - f(x)$), where ($f(x)$) is the aggregate position function of traders.[6]

The 'b' parameter plays a central role in the solvency model. It imposes a strict upper bound on the aggregate trader position function: ($\max\{f\} \leq b$).[6] This constraint ensures that the maximum potential payout for any single outcome (x_0) cannot exceed the initial backing amount (b), as the AMM must always be able to fulfill its obligation ($f(x_0)$) using the available backing.[6] While this provides a clear solvency guarantee up to the level of 'b', it introduces significant constraints on the market's expressiveness.

Specifically, the constraint ($\max\{f\} \leq b$) directly limits the market's ability to represent highly peaked distributions, which correspond to strong consensus or high certainty about a narrow range of outcomes.[6] Mathematically, distributions with lower variance (higher certainty) possess higher L2 norms and exhibit higher peak values. For instance, as derived in the analysis of Paradigm's paper, for Normal probability density functions traded on the platform, this constraint implies a lower bound on the achievable standard deviation: ($\sigma \geq \frac{k^2}{b^2\sqrt{\pi}}$), where (k) is the constant L2 norm invariant.[6] A smaller 'b' thus forces a larger minimum standard deviation, preventing the market from reflecting very precise predictions. While Paradigm suggests potential workarounds like "capped Gaussians" [6], these inherently distort the true representation of beliefs.

This reveals a fundamental trade-off embedded within the mechanism's structure: the 'b' parameter directly links the solvency guarantee for any single point outcome to the market's overall expressiveness regarding certainty. Increasing 'b' allows the market to represent sharper peaks (higher certainty) but necessitates a proportionally larger upfront capital commitment from LPs.[6] Conversely, a smaller 'b' reduces the initial capital requirement but restricts the market's capacity to reflect strong consensus around specific outcomes.

Furthermore, the 'b' parameter is largely static. It is set at the market's inception by the initial LP and, while subsequent LPs contribute liquidity proportional to the AMM's current position ($b - f(x)$), fundamentally increasing the overall backing 'b' appears to require coordinated action or specific mechanisms not fully detailed.[6] This contrasts with the dynamic nature often sought in DeFi protocols, where market parameters or liquidity might adapt based on real-time activity or total value locked.[8] The requirement for LPs to provide liquidity proportional to ($b - f(x)$) can also be complex and capital-intensive, particularly if the aggregate belief function ($f(x)$) becomes

highly non-uniform, potentially deterring the passive liquidity provision common in simpler AMM models.[6]

This reliance on a pre-funded, static backing parameter provided by dedicated LPs resembles more traditional financial structures, like a pre-funded insurance pool or reserve. While ensuring solvency within its limit, it potentially sacrifices the capital efficiency and dynamic adaptability that characterize many modern DeFi innovations, where risk might be collateralized more directly by active participants or where capital pools dynamically adjust to market conditions.[10] The search for alternative economic paradigms or distribution models often arises when existing frameworks exhibit such limitations or fail to adapt to new requirements.[12] This motivates the exploration of alternative mechanisms for distribution markets that can overcome the constraints imposed by the 'b' parameter.

1.3. Research Objectives and Contributions

This report addresses the limitations identified in existing distribution market models by pursuing three interconnected research objectives:

1. **Develop an Alternative Market Mechanism (Reduced Reliance on 'b'):** Propose and rigorously detail a novel mechanism for distribution markets that significantly reduces or eliminates the reliance on a large, static, externally provided initial backing parameter like 'b'. The focus is on exploring a "pure-market" or participant-funded model where the potential payout pool is primarily derived from the collective collateral committed by the traders themselves. The analysis will cover mathematical properties, incentive structures, and solvency guarantees, comparing the proposed mechanism against Paradigm's model and potentially LMSR-based approaches.
2. **Integrate a Native Token:** Design and analyze the integration of a native token (DMGT) into the proposed market mechanism (or adapt it to Paradigm's model if the alternative proves infeasible). This integration must satisfy specific constraints: avoid simple percentage-based transaction fees, contribute to a network effect, enable developer monetization (e.g., a 2% allocation with vesting), and possess sound intrinsic utility directly linked to the market's core function, potentially through tokenizing protocol state or risk parameters.[18]
3. **Identify High-Traction Applications:** Identify and justify specific application domains where the proposed distribution market model (either the novel mechanism or its tokenized version) could gain early traction. This involves demonstrating its advantages over existing market types (binary prediction markets, order books, traditional AMMs) for forecasting, speculation, or hedging over continuous outcomes in areas with latent demand, considering the current

technological and cultural landscape.[2]

The primary contribution of this report is the development and theoretical validation of a novel, participant-funded mechanism for distribution markets, coupled with a sophisticated tokenomics model designed for intrinsic utility and sustainable growth. By addressing the capital structure limitations of prior models and proposing concrete applications, this research aims to advance the state-of-the-art in continuous outcome prediction markets and their potential within the broader DeFi ecosystem.

1.4. Report Structure

The remainder of this report is structured as follows:
Section 2 provides a deeper analysis of Paradigm's Distribution Markets, focusing on the mechanics, the role of the 'b' parameter, solvency, and identified limitations.
Section 3 reviews foundational concepts and relevant prior work in market scoring rules, AMMs for continuous spaces, and dynamic liquidity models, laying the groundwork for the proposed alternative.
Section 4 introduces the novel Collateralized Distribution Function Market (CDFM) mechanism, detailing its conceptual design, mathematical specification, theoretical properties, and a comparative analysis against existing models.
Section 5 presents the proposed native token integration strategy for the DMGT token, covering its design principles, utility, issuance, distribution, and economic impact.
Section 6 identifies and analyzes high-traction application domains for the CDFM, justifying its suitability compared to alternatives.
Section 7 discusses practical implementation considerations, potential challenges, and directions for future research.
Section 8 concludes the report, summarizing the key findings and contributions.
Section 9 provides a comprehensive list of references.

2. Analysis of Paradigm's Distribution Markets

Paradigm's proposal introduces a sophisticated framework for trading on events with continuous outcomes, utilizing an automated market maker (AMM) that operates directly on functions representing participant beliefs. Understanding its mechanics, particularly the role of the backing parameter 'b' and the solvency mechanisms, is crucial for identifying limitations and motivating the development of alternative approaches.

2.1. Core Mechanics and Mathematical Framework

The core innovation lies in shifting from trading discrete outcome tokens (like "YES" or "NO") to trading "outcome function tokens".[6] A participant's position is represented by a function $f: \mathbb{R} \rightarrow \mathbb{R}^+$, where $f(x)$ denotes the number of contracts held for the specific outcome x within the continuous outcome

space (e.g., (\mathbb{R})).[6] If the event resolves to outcome (x_0), the holder of function (f) receives a payout of ($f(x\_0)$) dollars (or the base asset).[6]

The AMM itself holds an aggregate position function, initially derived from the backing parameter 'b'. The paper defines a constant function ($f(x) = b$), which guarantees a payout of (b) dollars regardless of the outcome (x_0). This function can be minted or redeemed for (b) dollars at any time.[6] The AMM's holding outcome function ($h(x)$) is then defined relative to this constant function and the aggregate trader position function ($f\_{agg}(x)$) (denoted simply as ($f(x)$) in 6):
[$h(x) = b - f(x)$]
This implies the AMM starts effectively holding the constant function (b) and sells portions of it to traders who build up the aggregate position ($f(x)$).[6] The AMM can sell up to ($f(x\_0)=b$) at any specific outcome (x_0), at which point its holding ($h(x\_0)$) becomes zero.[6]
Trading involves modifying the aggregate position function. When a trader wishes to change the market's belief from ($f(x)$) to ($g(x)$), they effectively trade the difference function ($\delta f(x) = g(x) - f(x)$) with the AMM.[6] The cost of this trade is determined by the AMM's pricing rule, which is derived from an invariant.

The invariant proposed by Paradigm is based on the L2 norm of the aggregate trader position function ($f(x)$):

where (k) is a constant determined at market initialization.[6] This invariant ensures that the overall "size" or magnitude of the market's aggregate belief, measured by the L2 norm, remains constant throughout trading. The cost for a trader to change the function from (f) to (g) is calculated based on maintaining this invariant, although the explicit cost formula derived from the L2 norm is not provided in the summarized snippets but is detailed in the original Paradigm paper.

2.2. The Role and Implications of the 'b' Parameter

The parameter 'b' serves as the foundational collateral or backing for the market, provided initially by the first liquidity provider (LP).[6] Its primary role is to guarantee the AMM's solvency by setting a ceiling on the potential payout for any single outcome.

The definition ($h(x) = b - f(x)$) and the implicit requirement that ($h(x) \ge 0$) (the AMM cannot sell what it doesn't have) directly leads to the constraint:
[$\max\_{x} f(x) \leq b$]
This inequality is the cornerstone of the solvency mechanism related to 'b'. It ensures that, irrespective of where the aggregate belief function ($f(x)$) peaks, its maximum value never exceeds the total backing (b). Since the payout at resolution (x_0) is proportional to ($f(x\_0)$), this constraint guarantees that the AMM's maximum liability for any single outcome is capped by the amount (b) it was initially endowed with.[6]
However, this solvency guarantee comes at the cost of limiting market expressiveness, particularly for distributions representing high certainty (low variance or highly

peaked beliefs). As noted previously, distributions with lower variance tend to have higher peak values for a given L2 norm (k). The constraint ($\max f \leq b$) therefore imposes a minimum variance (or maximum peak height) that the market can represent. For a Normal distribution, this translates directly to a lower bound on the standard deviation (σ), explicitly linking the backing parameter 'b' to the market's ability to reflect strong consensus: ($\sigma \geq \frac{k^2}{b^2\sqrt{\pi}}$).[6]

This creates an inherent tension. To allow the market to represent very precise predictions (small (σ)), 'b' must be sufficiently large. However, increasing 'b' requires a larger initial capital commitment from LPs and potentially increases the complexity of managing liquidity provision, as subsequent LPs must contribute assets proportional to (b - f(x)).[6] The parameter 'b' is static, fixed at initialization unless actively changed through further LP actions, meaning the market's capacity to represent certainty doesn't dynamically adjust with trading activity or the total value risked by traders. This static nature and the direct coupling of point-wise solvency with distributional expressiveness are significant limitations of the model.

2.3. Solvency Mechanisms and Collateralization

Solvency in Paradigm's Distribution Markets is maintained through a combination of four key elements [6]:

1. **The 'b' Parameter Constraint:** As discussed, ($\max f \leq b$) ensures the maximum payout for any single outcome (x_0) is limited by the initial backing (b). This acts as the ultimate backstop provided by the market's liquidity structure.
2. **The L2 Norm Invariant ((k)):** The constraint ($\|f\|_2 = k$) controls the overall "size" or magnitude of the aggregate trader position function. While not directly ensuring solvency in the sense of covering payouts, it prevents the function (f(x)) from growing indefinitely large in aggregate, indirectly contributing to stability.
3. **Trader Collateralization:** When a trader executes a trade that modifies the aggregate function from (f(x)) to (g(x)), they must post collateral sufficient to cover the maximum potential loss *created by their trade*. This loss occurs at the outcome (x) where the change (g(x) - f(x)) is most negative. The required collateral is ($-\min_x \{g(x) - f(x)\}$).[6] This ensures that the risk introduced by any individual trade is fully backed by the trader initiating it. The paper notes that computing this minimum might require numerical methods for complex functions like Normal distributions.[6]
4. **Liquidity Provider (LP) Contributions:** The initial LP provides the foundational collateral (b). Subsequent LPs add liquidity by contributing assets proportional to the AMM's current position (h(x) = b - f(x)). In return, they receive LP shares representing a claim on the AMM's assets and future fees. This mechanism

ensures that the AMM always holds sufficient assets (backing) to cover the potential payout represented by the current aggregate trader function (f(x)), up to the maximum limit of (b) for any single outcome.[6]

It is useful to distinguish the roles of LP collateral ('b') and trader collateral. The LP-provided backing 'b' guarantees the *maximum potential payout* at any single point (x), ensuring the AMM *could* pay out up to (b) if (f(x)) reached that level. Trader collateral, on the other hand, covers the *marginal increase in risk* the AMM assumes due to a specific trade altering the function (f(x)). The trader essentially pre-pays their worst-case loss relative to the state before their trade. However, the fundamental ability of the AMM to cover the existing function (f(x)) relies on the assets provided by LPs, ultimately tied to the initial 'b'. This hybrid solvency model differs conceptually from systems where the entire potential payout might be dynamically funded solely by the collateral staked by active traders.

2.4. Limitations and Critique

While Paradigm's model is innovative, its reliance on the 'b' parameter and the associated LP structure presents several limitations:

1. **Limited Expressiveness for Peaked Distributions:** The most prominent limitation, directly resulting from the (\max f \leq b) constraint, is the inability to represent distributions with very low variance (high certainty) unless 'b' is made impractically large.[6] This restricts the market's utility in domains where precise expert consensus might emerge, such as forecasting specific scientific parameters or AI model performance metrics. The suggested workaround of trading "capped Gaussians" [6] introduces artificial distortions into the market's representation of beliefs.

2. **Static Nature of 'b':** The backing parameter 'b' is typically fixed at market creation. Unlike dynamic AMMs where liquidity depth might adjust based on trading volume, fees, or time [8], Paradigm's 'b' does not automatically scale with market activity or the total capital committed by traders. Increasing 'b' requires explicit and potentially complex actions by LPs, making the market less adaptable to changing conditions or levels of participation.

3. **Complex and Potentially Capital-Intensive LP Requirements:** Liquidity providers must contribute assets proportional to (b - f(x)).[6] If the aggregate belief function (f(x)) becomes highly uneven (peaked in some areas, low elsewhere), the required collateral profile for LPs becomes complex to manage and potentially very capital-intensive in regions where (f(x)) is low (meaning (b-f(x)) is high). This complexity might deter passive LPs who prefer the simpler "deposit-and-forget" model of many standard AMMs (like Uniswap V2). It

demands active management or sophisticated strategies from LPs.

4. **Capital Efficiency Concerns:** The requirement for upfront backing 'b', potentially significantly larger than the capital actively traded or risked by participants at any given moment, raises questions about capital efficiency. In DeFi, there is a strong drive towards models where capital is utilized dynamically and efficiently, often with participant collateral directly securing liabilities.[10] Paradigm's model, while ensuring solvency up to 'b', retains a structure where a potentially large amount of capital must be pre-committed by LPs, separate from the traders' active positions and collateral. This structure might be less capital-efficient compared to a hypothetical model where the payout pool dynamically scales with the total collateral actively staked by traders.

These limitations motivate the exploration of alternative mechanisms that can retain the core idea of trading continuous distributions while mitigating the reliance on a large, static, externally provided backing parameter. The goal is to design a market that is potentially more capital-efficient, dynamically adapts to participation, and offers greater expressiveness, particularly for high-certainty predictions.

3. Foundations for Alternative Continuous Market Mechanisms

To develop a novel mechanism for distribution markets, it is essential to build upon the theoretical foundations laid by prior work in prediction markets, automated market making, and mechanism design, particularly focusing on approaches that handle continuous outcomes and explore alternative liquidity or solvency models.

3.1. Market Scoring Rules (MSRs) and LMSR

Market Scoring Rules (MSRs) provide a foundational framework for prediction markets, particularly those facilitated by an automated market maker.[23] MSRs are derived from the concept of proper scoring rules, which are functions designed to elicit truthful probability assessments from participants by rewarding accuracy.[1] A scoring rule ($S(r, \omega)$) assigns a score based on a reported probability distribution (r) and the actual outcome (ω). A rule is *strictly proper* if a risk-neutral agent maximizes their expected score by reporting their true beliefs.[1]

Robin Hanson extended this concept to create market mechanisms.[23] In an MSR-based market, a market maker maintains a state representing the current consensus probability distribution. When a trader interacts with the market maker, they effectively propose a new distribution, and the cost of their trade is determined by the change in a potential function (the cost function) associated with the underlying proper scoring rule. The trader's profit or loss is then determined by the

score difference based on the eventual outcome.[23]

The Logarithmic Market Scoring Rule (LMSR) is arguably the most well-known and widely studied MSR, invented by Robin Hanson.[23] It is based on the logarithmic scoring rule ($S(r, \omega) = a + b \log(r_\omega)$), where (r_ω) is the probability assigned to the outcome (ω) that occurred, and ($b > 0$) is a parameter controlling the market's liquidity or depth.[23]

In the market context, LMSR uses a cost function ($C(q)$), representing the total amount paid into the market maker to reach a state where (q_i) represents the number of outstanding shares for outcome (i). The cost function is defined as:
$$ C(q) = b \log \sum_{i=1}^{N} e^{q_i/b} $$
where (N) is the number of discrete outcomes.[24] The instantaneous price (p_i) for a share of outcome (i) is derived from the gradient of the cost function:
$$ p_i(q) = \frac{\partial C}{\partial q_i} = \frac{e^{q_i/b}}{\sum_{j=1}^{N} e^{q_j/b}} $$
These prices always sum to 1 and can be interpreted as the market's consensus probability for each outcome.[23]
LMSR possesses several desirable properties:

- **Bounded Loss:** The market maker's maximum possible loss is bounded by ($b \log N$), regardless of the trading sequence or the final outcome.[23] This provides a crucial solvency guarantee for the market operator.
- **Path Independence:** The final state (q) and total cost ($C(q)$) depend only on the net number of shares purchased for each outcome, not the order of trades.[25] This prevents certain forms of arbitrage ("money pumps").[23]
- **Incentive Compatibility:** For risk-neutral traders, interacting with the LMSR market maker incentivizes them to trade until the market prices match their true beliefs.[1]

However, LMSR also has limitations, especially when considering continuous outcomes:

- **Computational Complexity:** Standard LMSR operations (calculating cost and prices) require summing over all possible outcomes. For a large number of discrete outcomes, or when approximating a continuous space via fine discretization, this becomes computationally expensive, typically scaling linearly with the number of outcomes (N).[26]
- **Reliance on 'b':** The parameter 'b' controls the market's liquidity. A small 'b' leads to high price sensitivity (prices move rapidly with small trades), while a large 'b' leads to low sensitivity (prices are "sticky").[24] This parameter must be set *a priori* and doesn't adapt to market activity. This static liquidity is often cited as a drawback.[25]

- **Market Maker Loss:** While the loss is bounded, the LMSR market maker typically operates at an expected loss, effectively subsidizing information aggregation.[28]

3.2. AMMs for Continuous & Infinite Outcome Spaces

Addressing the limitations of LMSR for continuous or very large outcome spaces has been a significant area of research, leading to more sophisticated AMM designs.

Othman & Sandholm's Contributions:
Abraham Othman and Tuomas Sandholm have made substantial contributions to extending automated market making beyond simple finite settings.26 Their work often employs a framework based on convex analysis and duality, providing rigorous foundations for market makers operating over complex spaces.
A key insight is the duality between the market maker's liabilities (potential payouts) and the market's beliefs.[26] Instead of just probabilities over finite outcomes, beliefs can be represented more generally as *probability measures* on a measurable space ($(\Omega, \mathcal{F})$). This is crucial for handling continuous outcome spaces ($(\Omega = \mathbb{R})$ or $(\Omega =)$) because measures can capture distributions that lack density functions (e.g., point masses or singular distributions).[31] The market maker's liabilities are then represented by bounded measurable functions ($\ell: \Omega \to \mathbb{R}$), indicating the payout owed if outcome ($\omega \in \Omega$) occurs.[31]

The market maker operates based on a cost function ($C(\ell)$) defined over the space of these liability functions. The price of a security (representing a small change in liability (b)) is given by the Gâteaux derivative of the cost function.[31] Crucially, Chen, Ruberry, and Vaughan (building on Abernethy et al.[32]) showed that cost functions satisfying desirable economic properties (like no arbitrage and bounded loss) can be characterized via convex conjugates.[26] Specifically, ($C(\ell)$) can be derived from a convex function ($R(p)$) defined on the space of probability measures (beliefs) (p).

This framework allows for the design of market makers for continuous spaces that overcome previous impossibility results regarding bounded loss.[31] Gao and Chen had shown unbounded loss for continuous markets under the implicit assumption that beliefs must have density functions.[31] By allowing general probability measures and using the conjugate function framework, Chen et al. demonstrated that bounded loss *is* achievable if the conjugate function (R) is bounded on the set of achievable market beliefs.[31] They provide a concrete example of such a cost function for the interval () with a proven bounded loss of ($1 + \pi/4$).[31] This measure-theoretic approach provides the necessary theoretical machinery to construct solvent AMMs for truly continuous distributions without resorting to artificial discretization, directly addressing a

fundamental challenge.

Furthermore, Othman and Sandholm explored market makers that address the static liquidity issue of LMSR. They developed "liquidity-sensitive" AMMs where the price impact of a trade decreases as trading volume increases, mimicking the behavior of real markets.[25] One approach involves extending constant-utility cost functions with separate liquidity and profit functions.[26] The liquidity function uses proceeds from trades (effectively a dynamic spread) to increase the market maker's liquidity over time, moving away from reliance on a static 'b'.[26] Another approach uses homogeneous risk measures to define liquidity sensitivity.[25] These designs aim for greater realism and practicality, potentially enabling profitable market making.[25]

Dudík et al.'s Log-time Interval Markets:
Addressing the computational challenge of continuous spaces, Dudík, Wang, Pennock, and Rothschild proposed efficient market makers for trading interval securities.[26] An interval security pays $1 if the outcome (x) falls within a specified interval ([a, b]) and $0 otherwise. They presented two main designs:

1. **Log-time LMSR:** This design implements the standard LMSR cost function but uses a balanced binary tree data structure (an "LMSR tree") annotated with interval information and partial normalization constants. Queries and trades involving intervals can be processed by traversing paths in this tree, reducing the computational complexity from linear in the number of base intervals to logarithmic.[27] This makes LMSR feasible for a very large number of fine-grained intervals, approximating a continuous space. However, the market maker's loss bound still depends on the total number of base intervals (leaves in the tree) and the liquidity parameter 'b': $(b \log N)$.[27]

2. **Multi-resolution Linearly Constrained Market Maker (LCMM):** This more advanced design uses multiple parallel LMSR market makers, each operating at a different level of resolution (granularity of intervals), conceptually arranged in a hierarchy or tree.[27] For example, one level might trade intervals ([0, 0.5)) and ([0.5, 1]), while the next level trades (This design also achieves logarithmic time complexity for market operations.[27] Significantly, by carefully choosing the liquidity parameters (b_k) for each resolution level (k) such that the sum $(\sum_{k=1}^\infty k b_k = B^*)$ converges to a finite value (B^*), this multi-resolution LCMM achieves a *constant bounded loss* of $(B^* \log 2)$, independent of the market's precision or the number of effective intervals.[27] This demonstrates a practical construction for achieving near-continuous representation with guaranteed constant loss. However, while sophisticated, this model still relies on the *a priori* specification of the liquidity parameters (b_k) for

each resolution level. The liquidity isn't generated dynamically from participant collateral, placing it closer to the MSR/LMSR paradigm than a fully participant-funded approach.

3.3. Dynamic Liquidity and Participant-Funded Models

The limitations of static liquidity parameters ('b' in LMSR or Paradigm, (b_k) in LCMM) motivate the exploration of mechanisms with dynamic liquidity or alternative funding structures.

Dynamic liquidity refers to market models where the depth or price sensitivity adjusts based on certain conditions. Othman and Sandholm's liquidity-sensitive AMMs are one example.[25] Another example is the pm-AMM proposed by Paradigm for binary prediction markets, where the effective liquidity (L_t) decreases as the market approaches expiration (($t \to T$)) according to ($L_t = L_0 \sqrt{T - t}$), aiming to keep the expected loss-vs-rebalancing (LVR) constant over the remaining time.[8] Other dynamic AMM features include dynamic fees that adjust based on volatility or volume, or concentrated liquidity where LPs specify price ranges (though this is more common for asset swaps).[9]

Building on these ideas, the core concept for the novel mechanism proposed in this report is to shift the source of market backing away from externally provided, static parameters ('b' or (b_k)) and towards the participants themselves. The goal is a *participant-funded* model where the collateral committed by traders collectively forms the pool from which payouts are made.

In such a model, traders would contribute collateral not just to cover their maximum potential loss on a specific trade (as in Paradigm's model [6]), but their contribution would augment a shared pool backing all possible outcomes. The total size of this collateral pool, (C_{total}), would dynamically determine the market's overall capacity and potentially influence pricing. This contrasts sharply with models where a market maker entity (even an automated one like LMSR) provides liquidity and assumes bounded loss separately from the traders' positions.[24]

This participant-funded approach draws conceptual parallels with DeFi lending protocols like Aave or Compound.[10] In these protocols, the total value locked (TVL) by suppliers (lenders) forms the pool from which borrowers can draw funds, and the size of this pool dictates borrowing capacity and influences interest rates. Similarly, in a participant-funded distribution market, the total collateral actively staked by traders would determine the "height" or scale the market's distribution function can reach

and the maximum payout possible.

Such a model inherently links the market's depth, expressiveness, and solvency capacity directly to the total capital actively risked by participants. If traders collectively express strong conviction (high certainty) about a particular outcome range by committing significant collateral, the market could potentially represent a highly peaked distribution, overcoming the limitation imposed by a fixed 'b'. The market's capacity would scale dynamically with engagement. This aligns incentives differently: traders are not just betting against a house or an AMM, but are collectively underwriting the market's potential payouts through their pooled collateral. This promises greater capital efficiency, as the capital backing the market is precisely the capital actively participating in it, rather than requiring a separate, potentially underutilized, pool provided by external LPs. The challenge lies in designing the specific mechanism to ensure solvency and manage the dynamics of this shared collateral pool.

4. Proposed Novel Distribution Market Mechanism: The Collateralized Distribution Function Market (CDFM)

Building upon the limitations of existing models and the foundations reviewed, this section proposes a novel mechanism for distribution markets: the Collateralized Distribution Function Market (CDFM). The CDFM aims to reduce reliance on a static, externally provided backing parameter ('b') by deriving the market's payout capacity dynamically from the collateral contributed by participants themselves.

4.1. Conceptual Design: Participant-Funded Payout Pool

The central idea of the CDFM is to create a market where the collective collateral committed by traders forms the primary, or sole, source of funds for payouts at resolution. Instead of a separate market maker entity providing liquidity and bearing bounded loss (like LMSR [24]) or relying on an initial LP to set a backing limit 'b' (like Paradigm [6]), the CDFM operates based on a shared collateral pool, (C_{total}), funded by the net cost of trades.

When a trader enters a position expressing their belief about the outcome distribution, the cost associated with that trade (representing the shift in the market's aggregate belief) is added to the total collateral pool (C_{total}). Conversely, when a trader reduces or exits a position, collateral is withdrawn from the pool. The total collateral (C_{total}) at any time represents the net value committed by all participants to back the current market state.

This (C_{total}) dynamically determines the market's capacity. The maximum payout for any outcome (x_0) at resolution is ultimately constrained by the available collateral (C_{total}). This contrasts with Paradigm's model where the maximum payout is fixed by 'b'.[6] In the CDFM, if participants collectively express strong conviction and commit substantial collateral, (C_{total}) will be large, potentially allowing the market to represent highly peaked distributions and offer significant payouts. If market participation or conviction wanes, (C_{total}) will shrink, naturally limiting the market's scale.

This participant-funded approach aims for higher capital efficiency, as the capital backing the market is precisely the capital actively risked by traders. It also introduces a dynamic element, where market depth and expressiveness scale directly with participant engagement.

4.2. Mathematical Specification

To formalize the CDFM, we define its state, invariant, pricing, cost, collateral dynamics, and payout structure. We draw inspiration from the measure-theoretic framework for continuous markets [31] and cost-function-based AMMs.[33]

- **State Variables:** The market state is defined by two components:
  - The aggregate outcome function ($f(x)$): Represents the net quantity of outcome securities held by all traders for each outcome ($x \in \Omega$) (where (Ω) is the continuous outcome space, e.g., ($\mathbb{R}$) or ()). ($f(x)$) can be interpreted as reflecting the market's unnormalized belief density or payout liability function.
  - The total collateral pool (C_{total}): A scalar value representing the total amount of collateral (e.g., in USDC) held by the market contract, derived from the net cost paid by traders.
- Invariant Concept: We propose an invariant that links the aggregate function ($f(x)$) and the total collateral (C_{total}). Instead of a fixed L2 norm 6 or a standard LMSR cost function independent of total collateral, we consider an invariant of the form:

  Here, (V) is a strictly convex function, analogous to the potential function underlying a proper scoring rule or cost-function AMM.31 A natural choice, inspired by LMSR, is ($V(y) = e^y$). (R) is a monotonically increasing function that relates the integrated "cost" of the function ($f(x)$) to the total collateral pool. Possible choices for (R) include:
  - ($R(C_{total}) = C_{total}$): Linear relationship.
  - ($R(C_{total}) = \alpha \log(C_{total})$) or ($R(C_{total}) = \alpha \sqrt{C_{total}}$):

Introducing non-linear scaling. The choice of (V) and (R) significantly impacts market dynamics. For simplicity, let's initially explore $(V(y) = e^y)$ and $(R(C_{total}) = C_{total})$ (or proportional to it). The invariant becomes: [\int_{\Omega} e^{f(x)} dx = C_{total}] *(Note: This specific form needs careful analysis regarding units and scaling, but serves as a starting point. The key is the dependency on (C_{total}).)*

- Pricing Logic: The instantaneous price $(p(x))$ for acquiring a marginal unit of the outcome function at point (x) should be related to the derivative of the cost function (V). If a trade changes $(f(x))$ to $(f(x) + \delta f(x))$ and (C_{total}) to $(C_{total} + \delta C)$, the change in the invariant gives:

  The cost (δC) for acquiring the portfolio $(\delta f(x))$ is $(\int p(x) \delta f(x) dx)$. This suggests a pricing rule:

  Using $(V(y) = e^y)$ and $(R(C) = C)$, this yields $(p(x) = e^{f(x)})$. This price function is unnormalized. Normalization might be necessary depending on the payout rule.

- Cost Function: The cost (ΔC) for a trader to change the market function from $(f_{old}(x))$ to $(f_{new}(x))$ is the collateral they must add to (or receive from) the pool. This cost is determined by the change required in (C_{total}) to satisfy the invariant:

  [\Delta C = C_{new} - C_{old}]
  If $(\Delta C > 0)$, the trader pays this amount into the pool. If $(\Delta C < 0)$, the trader receives this amount from the pool.

- **Collateral Dynamics:** When a trade occurs resulting in a cost $(\Delta C > 0)$, the trader posts this collateral, and (C_{total}) increases by (ΔC). When a trade results in $(\Delta C < 0)$, the trader receives $(|\Delta C|)$ from the pool, and (C_{total}) decreases by $(|\Delta C|)$. Thus, (C_{total}) represents the net accumulated cost paid by traders to establish the current aggregate function $(f(x))$.

- Payout Structure: At the resolution time (t_{res}), the true outcome (x_0) is determined (via an oracle). The total collateral (C_{total}) available in the pool is distributed among the holders of positive positions $(f_i(x_0))$ at that outcome. Let $(f(x) = \sum_i f_i(x))$ be the aggregate function, where $(f_i(x))$ is the position of trader (i). A robust payout rule ensuring the total payout exactly equals (C_{total}) is:
  [\text{Payout to trader } i = f_i(x_0) \times \frac{C_{total}}{f(x_0)} \quad \text{if } f_i(x_0) > 0 \text{ and } f(x_0) > 0]

$$[\text{Payout to trader } i = 0 \quad \text{otherwise}]$$

This rule proportionally distributes the entire collateral pool (C_{total}) based on each trader's stake ($f_i(x_0)$) at the winning outcome (x_0), relative to the total aggregate stake ($f(x_0)$) at that outcome.

- **Solvency Constraint:** The crucial condition for solvency is that the mechanism must prevent states where ($f(x_0) = 0$) while ($C_{total} > 0$) if (x_0) is a possible outcome, as this would leave collateral undistributed. More importantly, the mechanism must inherently manage the relationship between ($f(x)$) and (C_{total}) such that the system remains well-defined. The pricing function ($p(x) = V'(f(x))/R'(C_{total})$) naturally increases as ($f(x)$) increases, making it progressively more expensive to push the function higher. If (C_{total}) decreases (due to net selling), ($R'(C_{total})$) might change, potentially increasing prices further and discouraging buying, thus acting as a stabilizing feedback loop. However, explicit constraints or dynamic adjustments (e.g., fees scaling inversely with (C_{total})) might be necessary to prevent edge cases or instabilities, particularly if (C_{total}) approaches zero.

4.3. Theoretical Properties

We now analyze the key properties of the proposed CDFM mechanism.

- **Solvency Guarantees:**
  - By design, the payout mechanism distributes exactly the total collateral (C_{total}) available at resolution. Therefore, the market maker (the smart contract) is always solvent in the sense that it can always meet its payout obligations using the funds provided by the participants. The risk is borne collectively by the participants.
  - The critical risk shifts from the market maker insolvency (as in LMSR needing its bound ($b \log N$)) to the *value of the collateral pool (C_{total})* relative to the participants' expectations or the magnitude of ($f(x)$). If (C_{total}) shrinks significantly due to net selling pressure or withdrawals before resolution, the payout per unit of ($f(x_0)$) will be lower, even for winning bets. This is analogous to impermanent loss in standard AMMs or the risk in undercollateralized lending protocols.[10]
  - Compared to Paradigm's model, solvency is not capped by a fixed 'b'. The potential payout scales with (C_{total}). This allows for potentially much higher payouts and the representation of sharper peaks if participants collectively commit large amounts of collateral. However, it also introduces the risk of (C_{total}) depletion impacting payout rates, a risk absent in Paradigm's model up to the limit 'b'. Mechanisms might be needed to manage extreme

(C_{total}) volatility, perhaps through dynamic fees or temporary lock-ups, drawing parallels to DeFi risk management.[10]

- **Incentive Compatibility:**
  - The incentive properties depend on the choice of (V) and (R). If (V) corresponds to a strictly proper scoring rule (like the negative logarithm, leading to $(V(y)=e^y)$), and (R) is chosen appropriately, the mechanism could potentially incentivize risk-neutral traders to push the implied distribution $(p(x) \propto V'(f(x)))$ towards their true beliefs. A formal proof would require analyzing the expected utility maximization problem for a trader interacting with the CDFM.
  - Since collateral provision is intrinsically linked to taking a position $(f_i(x))$, the incentive to provide collateral is simply the incentive to trade based on perceived mispricings or to express one's beliefs. There are no separate LPs with distinct incentives. Participants collectively underwrite the market through their trades.

- **Expressiveness:**
  - The CDFM's ability to represent peaked distributions is not limited by a static 'b'. Instead, it is limited by the collective willingness of participants to contribute collateral (C_{total}). If the market develops strong consensus around a narrow outcome range, participants backing this view will contribute significantly to (C_{total}), allowing $(f(x))$ to reach high values in that region (as permitted by the pricing function linked to (C_{total})). This suggests potentially better expressiveness for high-certainty scenarios compared to Paradigm's model, provided sufficient participant capital commitment.

- **Computational Tractability:**
  - Calculating the cost $(\Delta C = C_{new} - C_{old})$ involves computing integrals $(\int V(f(x)) dx)$. For general functions $(f(x))$ and (V), this requires numerical integration, which can be computationally intensive, especially for on-chain execution.
  - To ensure tractability, practical implementations might need to:
    - Restrict the functional form of $(f(x))$ (e.g., piecewise constant, piecewise linear, or represented by basis functions like splines or Fourier series).
    - Choose specific forms for (V) and (R) that allow for analytical or efficient numerical solutions.
    - Adapt tree-based structures similar to those used by Dudík et al. [27] if the outcome space is discretized or represented hierarchically, potentially achieving logarithmic complexity.
  - The payout calculation $(f_i(x_0) \times (C_{total}/f(x_0)))$ is computationally

simple once $(f(x\_0))$ and (C_{total}) are known.

4.4. Comparative Analysis

To clarify the positioning of the CDFM, we compare it against Paradigm's Distribution Market (DM) and the standard LMSR framework adapted for continuous outcomes (e.g., via discretization or log-time interval methods).

Table 4.4.1: Comparison of Distribution Market Mechanisms

Feature	Paradigm DM	LMSR (Continuous Adaptation)	CDFM (Proposed)
Core Invariant	Constant L2 Norm: (\	f\	_2 = k)
Liquidity Source	External LPs (initial 'b' + proportional additions)	Market Maker Parameter 'b' (or (b_k) in LCMM)	Participant Collateral (dynamically funds (C_{total}))
Solvency Basis	Max payout per outcome $(\le b)$ (LP-backed)	Market Maker loss bounded by $(b \log N)$ or $(B^* \log 2)$	Total payout equals (C_{total}) (Participant-backed)
Handling Peaked Distr.	Limited by $(\max f \le b)$	Limited by 'b' sensitivity / discretization effects	Potentially better, scales with (C_{total})
Dynamic Adaptation	Low (static 'b', LP actions needed)	Low (static 'b' or (b_k))	High (market depth/capacity scales with participant collateral (C_{total}))
Capital Efficiency	Moderate (requires pre-funding 'b')	Moderate/Low (MM capital separate from trades)	Potentially High (collateral directly backs market, no separate MM capital)
Key Limitation(s)	Static 'b', LP complexity, peak limits	Computational cost, static liquidity 'b'	(C_{total}) volatility risk, computational complexity, bootstrapping

			liquidity

Discussion:

The comparative analysis highlights the distinct trade-offs offered by the CDFM. By shifting the liquidity and solvency foundation from an external parameter ('b' or related constructs) to the dynamically pooled collateral of participants ((C_{total})), the CDFM achieves several potential advantages:

- **Elimination of Static Bottlenecks:** It removes the hard constraint imposed by 'b' on representing peaked distributions and avoids the need for dedicated, external LPs managing complex positions relative to $(b - f(x))$.
- **Dynamic Scaling:** Market depth and expressiveness naturally scale with the total capital committed by participants, making the market potentially more responsive to shifts in conviction and participation.
- **Capital Efficiency:** The capital backing the market's potential payouts is the same capital actively risked by traders, potentially leading to more efficient use of capital compared to models requiring separate, pre-funded reserves.

However, these advantages come with new challenges:

- **Solvency Risk Profile:** While the mechanism itself is always solvent relative to (C_{total}), the *value* distributed to winners depends on the stability of (C_{total}). Significant net selling or withdrawals could deplete the pool, reducing payout rates. This introduces a collective risk shared among participants, requiring robust mechanism design (e.g., choice of V, R) and potentially dynamic risk management features.
- **Computational Hurdles:** Implementing the integral-based invariant and cost function efficiently on-chain remains a significant challenge, likely requiring approximations or specific functional forms.
- **Bootstrapping:** Attracting sufficient initial collateral (C_{total}) to provide meaningful market depth in a purely participant-funded model might require initial incentive programs or temporary hybrid structures.

Compared to LMSR adaptations, CDFM offers a fundamentally different liquidity model (participant-funded vs. MM-parameter) and potentially greater flexibility, though potentially at the cost of LMSR's simpler bounded loss guarantee for the *market maker*. Compared to Paradigm's DM, CDFM sacrifices the fixed-cap solvency guarantee of 'b' for potentially greater expressiveness and dynamic adaptation, replacing LP dependency with participant-driven collateralization. The choice between these models depends on the specific requirements for expressiveness,

capital efficiency, risk tolerance, and implementation complexity.

5. Native Token Integration Strategy: The Distribution Market Governance & Utility Token (DMGT)

Integrating a native token into a DeFi protocol requires careful design to ensure the token provides genuine utility, fosters positive network effects, aligns incentives, and avoids extractive mechanisms like simple transaction fees that can deter usage. This section proposes a tokenomics model for the Distribution Market Governance & Utility Token (DMGT), designed specifically for the CDFM mechanism (or adaptable to other distribution market models), adhering to the principles outlined in the user query.

5.1. Token Design Principles and Constraints

The design of DMGT is guided by the following core requirements derived from the user query and best practices in sustainable tokenomics [39]:

1. **Avoid Standard Fees:** The token's role must not rely on a simple percentage-based take-rate on trading volume, as this can deter arbitrageurs crucial for price discovery and market efficiency [User Query].
2. **Foster Network Effects:** The token mechanism should contribute to making the protocol intrinsically more valuable or useful as adoption and usage grow.[39]
3. **Enable Developer Funding:** The model must allow for protocol developers to be rewarded, suggesting a 2% pre-mine or similar allocation with appropriate vesting schedules.[44]
4. **Sound Value & Intrinsic Utility:** The token must have a logical, non-forced role tied directly to the market's function. Its value should stem from genuine utility or demand related to protocol operation, not solely from speculation or farmed yield.[21] Holding/acquiring the token should be encouraged through this utility.
5. **Creative Solutions:** Exploration of structurally embedded roles, potentially involving the tokenization of protocol state, positions, or specific functions, is encouraged.[20]

5.2. Review of Relevant Token Models & Utility Mechanisms

Before proposing the DMGT mechanism, we review existing DeFi token models that offer utility beyond simple fees and align with the design principles:

- **Governance:** Tokens granting holders voting rights on protocol parameters, upgrades, and treasury management are common (e.g., UNI [51], AAVE [37], MKR [52]). Governance power provides intrinsic utility, especially for protocols managing significant value or complex risk parameters.[40] Vote-escrow (ve) models (e.g.,

veCRV [55]) enhance governance by weighting votes based on lock duration, aiming to align incentives with long-term protocol health.[61]

- **Staking for Yield/Rewards/Security:** Many protocols incentivize token holders to stake their tokens, removing them from circulating supply and contributing to network security (in PoS) or stability. Stakers often receive rewards in the form of protocol fees, inflation, or both (e.g., SNX stakers receive fees and inflation rewards [65], ETH stakers receive issuance rewards, Curve veCRV holders receive protocol fees [56]). Staking provides a direct economic incentive for holding and locking tokens.[19]
- **Discount / Access Utility:** Tokens can grant holders access to premium features, reduced fees, or enhanced services (e.g., BNB for reduced trading fees on Binance [19], utility tokens granting access [70]). This directly links token holding to usage benefits.[18]
- **Value Accrual Mechanisms:** Protocols capture value for token holders through various means beyond direct fees:
  - *Fee Distribution:* Distributing protocol-generated revenue (e.g., trading fees, interest differentials) to token holders or stakers (e.g., veCRV [57], SNX [73]).
  - *Buyback and Burn:* Using protocol revenue to buy back tokens from the market and permanently remove them from circulation (burn), creating deflationary pressure (e.g., MKR uses stability fees to buy and burn MKR [74], BNB quarterly burns [58]).
- **Tokenization of State/Positions:** Representing specific user states or positions within a protocol as distinct tokens, often NFTs or specialized ERC20s. Examples include:
  - *LP Tokens:* Representing a user's share in a liquidity pool (e.g., Uniswap V2 LP tokens, Balancer Pool Tokens (BPT) [37]). Uniswap V3 uses NFTs to represent concentrated liquidity positions.[78] These tokens can often be staked or used as collateral elsewhere in DeFi.[78]
  - *Vote-Locked Tokens (veTokens):* Often represented as NFTs in newer implementations (ve(3,3) model [59]) to allow trading of locked positions.
  - *Real-World Assets (RWAs):* Tokenizing off-chain assets like real estate or bonds to bring them into DeFi.[20]
- **Developer Funding:** Common models include allocating a percentage of the initial token supply to the team/foundation, subject to vesting schedules to align long-term incentives and prevent immediate selling pressure.[39] Vesting typically involves a cliff (period before any tokens unlock) followed by linear release over several years.[45] This contrasts with "fair launch" models where no tokens are pre-allocated [91], though fair launches can struggle with initial funding.[91] Decred's model involved developers purchasing premined tokens at a fixed rate or

receiving them for work performed at that rate.[93]

A key observation is that robust token models often layer multiple utilities. For instance, MKR combines governance with value accrual via burning.[53] SNX combines staking for collateralization with fee/inflation rewards and governance.[65] veCRV combines governance influence, LP reward boosting, and fee sharing.[55] This suggests a multi-faceted approach for DMGT. Additionally, the trend towards tokenizing specific protocol states (LP positions, locked votes) offers a promising avenue for creating unique, non-speculative utility.[20]

5.3. Proposed Token Mechanism: DMGT - Staked Governance & Risk Parameterization

Based on these principles and precedents, we propose the Distribution Market Governance Token (DMGT) with the following core utilities designed for the CDFM mechanism:

- **Token Name:** DMGT (Distribution Market Governance Token)
- **Core Utility 1: Staked Governance over Risk Parameters:**
  - **Mechanism:** DMGT holders can stake their tokens into a governance contract. Staked DMGT (sDMGT) grants voting power in the protocol's governance system. A vote-escrow mechanism (similar to veCRV [61]) could be implemented, where longer staking periods grant proportionally more voting power (veDMGT), further aligning incentives with long-term protocol health.
  - **Governance Domain:** The primary and most critical function governed by DMGT holders is the setting and tuning of the CDFM's risk parameters. Given that the CDFM's solvency and behavior are intrinsically linked to the dynamics of the participant-funded collateral pool (C_{total}) and its relationship with the aggregate function ($f(x)$) (defined by (V) and (R)), governing these parameters is crucial. Specific governable parameters could include:
    - Parameters within the cost potential function ($V(f(x))$).
    - Parameters defining the linking function ($R(C_{total})$).
    - Thresholds or rules for dynamic fee adjustments based on (C_{total}) levels, market volatility (($f(x)$) changes), or proximity to resolution.
    - Minimum collateral requirements or constraints on ($f(x)$) relative to (C_{total}).
    - Selection/approval of oracles for market resolution.
  - **Intrinsic Value:** This governance role gives DMGT direct, intrinsic utility tied to the core function and stability of the CDFM protocol.[21] Correctly parameterizing the market is essential for its success and safety, making control over these parameters valuable. This is analogous to MKR holders

governing stability fees, collateral types, and debt ceilings in MakerDAO to maintain the DAI peg and system solvency.[53]

- **Core Utility 2: Staking for Reduced Mechanism Costs / Enhanced Payouts (Optional Add-on):**
  - **Mechanism:** Users who stake DMGT (or hold veDMGT) could receive a discount on the mechanism cost (ΔC) when making trades. This discount could scale with the amount or duration of the stake. Alternatively, or additionally, stakers could receive a small multiplier on their payout ($f_i(x_0) \times (C_{total}/f(x_0))$) at resolution.
  - **Incentive:** This provides a direct economic benefit for holding and staking DMGT, rewarding active market participants and encouraging deeper engagement with the protocol.[18]
  - **Constraint Compliance:** This mechanism avoids a direct percentage fee on trade volume. The "cost" is inherent in the CDFM's core pricing derived from (V) and (R); staking DMGT provides a rebate or enhancement related to this fundamental mechanism cost, rather than imposing an additional layer of fees.
- **Core Utility 3 (Creative Option): Tokenizing Market Certainty/Risk (MCT):**
  - **Mechanism:** Explore the creation of a secondary token, the Market Certainty Token (MCT), potentially implemented as an ERC-1155 (semi-fungible) or ERC-721 (non-fungible) token. Users could mint MCT by staking DMGT alongside contributing collateral to a specific market or even a specific *region* of a market's outcome function (f(x)).
  - **Representation:** The amount or properties of the minted MCT could represent the "certainty" or "risk contribution" associated with the staked DMGT and the collateral position. For example, staking DMGT to back a position in a highly peaked region of (f(x)) might mint more MCT or MCT with specific attributes reflecting high conviction.
  - **Utility of MCT:** MCT could grant further benefits within the protocol, such as a larger payout multiplier, priority access to new markets, or enhanced governance weight on parameters related to the specific market it was minted against. MCT could also potentially be made tradable on secondary markets, creating a derivative representing confidence or risk exposure within specific distribution markets.
  - **Intrinsic Value:** This approach directly tokenizes a component of the protocol's state – the interplay between governance staking (DMGT) and market participation (collateral/position).[20] Its value derives from its functional benefits within the protocol or its informational content as a tradable representation of market conviction.

- **Network Effects:**
  - The governance utility (Utility 1) creates a core network effect: as the CDFM protocol gains adoption and manages more value ((C_{total})), the importance of governing its risk parameters increases. This drives demand for DMGT from participants who wish to influence these parameters to protect their positions or steer the protocol. Increased demand and utility enhance DMGT's value, attracting more users and stakers, creating a positive feedback loop.[39]
  - The staking discount/boost (Utility 2) directly links token holding to usage benefits, encouraging active traders to acquire and stake DMGT, further reinforcing demand.
  - The MCT concept (Utility 3) could create additional network effects if MCTs become valuable instruments for signaling or hedging, attracting participants interested in these novel derivatives.
- **Avoiding Standard Fees:** The model explicitly avoids percentage-based trading fees. Value accrues to DMGT holders primarily through the utility derived from governance, potential staking benefits (discounts/boosts), and the potential value appreciation of DMGT (and MCT, if implemented) tied to protocol growth and success. If the core CDFM mechanism is designed to capture a small spread or fee implicitly through the (V) and (R) functions (e.g., ensuring (C_{total}) slightly exceeds the theoretical minimum cost), this captured value could be directed towards a buy-and-burn program for DMGT [74] or distributed to sDMGT/veDMGT holders, providing direct value accrual without explicit trade fees.

5.4. Issuance, Distribution, and Developer Allocation

A carefully planned issuance and distribution strategy is crucial for decentralization, community building, and long-term sustainability.[39]

- **Initial Supply & Allocation:**
  - Define a fixed maximum supply for DMGT (e.g., 1 billion tokens) to ensure long-term scarcity, similar to Bitcoin.[40]
  - **Developer Allocation (2%):** Allocate 20 million DMGT (2% of max supply) to the core founding team, contributors, and potentially a foundation responsible for initial development. This allocation should be subject to a standard vesting schedule, such as a 4-year linear vest with a 1-year cliff, to ensure long-term commitment and prevent early market dumping.[41] This aligns with common practice and the user's suggestion.
  - **Community & Ecosystem Growth (>=50%):** Allocate a substantial portion (e.g., 500+ million DMGT) for distribution to the community over time. This is

crucial for decentralizing governance and incentivizing adoption.[40] Distribution mechanisms could include:

- *Retroactive Airdrop:* Reward early users, testers, or participants in related communities (e.g., prediction market users, DeFi governance participants).[89]
- *Participation Mining:* Distribute DMGT over several years as rewards for desired behaviors within the CDFM protocol, such as providing initial collateral to bootstrap markets, achieving high trading volume (while avoiding wash trading incentives), or actively participating in governance voting.[90]
- *Ecosystem Grants:* Allocate tokens to a treasury managed by DMGT governance to fund future development, integrations, research, and community initiatives.[89]

  - **Early Backers/Sale (Optional, <=20%):** A smaller portion could be allocated to strategic partners or sold in private/public rounds to raise initial capital for development, audits, and legal expenses. These allocations should also have vesting schedules, potentially longer than the team's.[45] Prioritize broad distribution over concentration.
  - **Treasury Reserve (Remainder):** Keep a portion in a community-controlled treasury for future unforeseen needs or strategic initiatives, governed by DMGT holders.

- **Ongoing Emissions (Careful Consideration):**
  - While a fixed supply provides scarcity, low, controlled inflation might be considered to fund ongoing staking rewards or participation incentives, ensuring continued engagement.[69]
  - If implemented, the inflation rate should be low (e.g., 1-2% annually after initial distribution phase) and ideally controllable via DMGT governance, allowing the community to adapt the monetary policy based on protocol needs and market conditions.[55] Synthetix initially used inflation but later moved to cap supply [73], highlighting the need for flexibility. Any emission schedule must be transparent and predictable.[40]

5.5. Economic Incentives and Impact Assessment

The proposed DMGT tokenomics aims to create a balanced ecosystem incentivizing various stakeholders.

- **Incentives:**
  - *Acquiring DMGT:* Users are incentivized to acquire DMGT to gain influence over critical risk parameters (protecting their capital in CDFM), potentially

receive trading cost discounts or payout boosts, speculate on protocol success, or mint/use MCTs (if implemented).

- *Staking DMGT:* Staking (especially long-term locking via veDMGT) is incentivized by increased governance power, potentially higher rewards/discounts, and potentially direct yield from protocol revenue distribution or buy-and-burn mechanisms.
- *Participating in Governance:* Active governance participation is incentivized by the desire to shape the protocol's rules favorably and ensure its stability and growth, which in turn benefits DMGT value.

- **Impact Assessment:**
  - *Market Participation:* The utility linked to governance and potential trading benefits should attract users who are invested in the protocol's long-term success, potentially leading to more informed governance and stable participation compared to purely speculative tokens.
  - *Liquidity (CDFM Collateral):* DMGT itself is not proposed as direct collateral for the CDFM mechanism to avoid complex recursive dependencies and risks. (C_{total}) would likely be funded by stablecoins (e.g., USDC) or major assets (e.g., ETH). Staking DMGT removes it from circulation, potentially impacting its market price but not directly the CDFM's collateral pool.
  - *Governance Dynamics:* Vote-escrow locking (veDMGT) can mitigate short-term speculation in governance but raises concerns about potential plutocracy or the influence of large, long-term holders ("whales").[54] Mechanisms like quadratic voting or delegation could be explored to enhance decentralization.
  - *Protocol Value Capture:* Value accrues to DMGT through its governance utility and potential economic benefits (discounts, yield). The success of this model depends on the CDFM protocol achieving significant usage and demonstrating the value of its unique market mechanism.[99]

Table 5.5.1: DMGT Token Utility and Incentives Summary

Utility Feature	Mechanism	Incentive for User	Contribution to Network Effect	Alignment with User Query Constraints
Governance over Risk Params	Stake DMGT (potentially veDMGT) for voting power on CDFM	Influence protocol rules, ensure stability, protect own capital invested	Attracts long-term aligned users; stable governance	Intrinsic utility tied to core function; fosters network effect; avoids direct

	parameters (V, R, fees).	in markets.	enhances protocol trust & value.	trade fees.
Staking Discounts/Boosts	Stake DMGT (or veDMGT) to receive reduced mechanism costs or enhanced payouts.	Lower trading costs, higher potential profits from market participation.	Rewards active usage and token holding, increasing demand for DMGT proportional to activity.	Intrinsic utility for active traders; fosters network effect (usage drives token demand); avoids direct trade fees.
Tokenized Certainty/Risk (MCT)	Stake DMGT + collateral to mint secondary token (MCT) representing conviction/risk.	Potential for enhanced rewards, signaling, or trading MCT as a derivative.	Creates new layer of interaction & information; attracts users interested in novel derivatives.	Creative solution; tokenizes protocol state/risk; utility tied to market function; avoids direct trade fees.
Developer Funding	2% initial allocation to team/foundation with 4-year vesting / 1-year cliff.	N/A (Developer incentive)	Enables initial and ongoing protocol development, crucial for network growth.	Allows developer monetization (2% vested); standard practice for alignment.
Community Distribution	>=50% via airdrops, participation mining, grants, governed treasury.	Rewards for early adoption, usage, governance participation; access to funding.	Promotes decentralization, broad ownership, user acquisition, and ecosystem growth.	Fosters network effect through wide distribution; aligns with community-centric ethos; avoids concentration seen in some pre-mines.

This multi-faceted tokenomics model for DMGT aims to create a sustainable ecosystem around the CDFM protocol, providing genuine utility linked to governance

and participation, enabling developer funding, and fostering network effects without resorting to simple transaction fees.

6. High-Traction Application Domains for CDFM

A novel market mechanism like the Collateralized Distribution Function Market (CDFM), particularly with its participant-funded structure and potential for enhanced expressiveness, requires identification of specific application domains where its unique properties offer tangible advantages over existing solutions. The goal is to find areas with latent demand for trading or aggregating beliefs about continuous outcomes where traditional markets fall short.

6.1. Identifying Potential Use Cases for Continuous Outcome Markets

The suitability of a domain for CDFM hinges on several factors: the continuous nature of the outcome, the value derived from knowing the full probability distribution (not just a point estimate or binary outcome), the inadequacy of current market mechanisms, and the potential alignment with CDFM's specific features (participant funding, dynamic depth, handling of peaks). Based on these criteria, several promising areas emerge:

1. **AI/ML Model Performance & Uncertainty:** The performance of complex AI models (e.g., large language models, computer vision systems) often involves continuous metrics like accuracy, loss scores, F1-scores, or even the distribution of specific internal parameters (weights, embeddings) after training or fine-tuning. Predicting the *distribution* of these outcomes is crucial for model selection, risk assessment, and understanding model uncertainty. Experts (researchers, data scientists) may have strong, potentially peaked beliefs about these outcomes.[100]

2. **Climate Change Variables:** Forecasting long-term climate variables like global mean temperature anomalies, regional temperature distributions, sea-level rise, or atmospheric CO_2 concentrations involves significant uncertainty and continuous outcomes. Prediction markets could aggregate diverse scientific opinions and model outputs.[107] The distributional information is vital for policy-making and risk assessment.[111]

3. **Economic Indicators:** Key economic indicators such as GDP growth rates, inflation (CPI), unemployment rates, or interest rates are continuous variables whose future distributions are of immense interest to policymakers, businesses, and investors.[113] While point forecasts exist, markets revealing the market-implied probability distribution offer richer insights into consensus and uncertainty.[119]

4. **Complex Project Outcomes:** Large-scale projects (construction, software

development, R&D) often face uncertainty regarding completion dates, final costs, or achievement of key performance indicators (KPIs). Forecasting the *distribution* of these continuous outcomes can provide a more realistic picture for planning and risk management than single-point estimates.[120] CDFM could aggregate dispersed knowledge within project teams or stakeholder groups.

5. **Parametric Insurance Triggers:** Parametric insurance contracts pay out based on the observed value of a pre-defined, objective index exceeding a certain threshold (e.g., wind speed for hurricane insurance, rainfall deficit for drought insurance, Richter scale magnitude for earthquake insurance).[126] A distribution market trading directly on the probability distribution of the underlying index itself could provide a transparent mechanism for pricing these contracts, hedging exposure, and assessing basis risk.

6. **Futarchy and Decision Markets:** Futarchy proposes using prediction markets to guide decisions by betting on which policy will lead to a better outcome according to a predefined metric.[133] If the metric is continuous (e.g., GDP, market capitalization, user satisfaction score), a distribution market like CDFM could predict the full distribution of the metric conditional on each policy choice, offering a more nuanced comparison than binary markets.

6.2. Model Suitability Analysis

The proposed CDFM mechanism, with its participant-funded collateral pool and potential for dynamic scaling, offers specific advantages in these domains compared to existing alternatives:

- **Binary Prediction Markets:** These are fundamentally limited to Yes/No outcomes or discretized ranges.[4] They cannot capture the shape, variance, or multimodality of a continuous distribution, making them unsuitable for applications where this richer information is valuable (e.g., understanding uncertainty in AI performance, climate projections, or economic forecasts).
- **Order Book Exchanges:** While capable of trading continuous assets (like stocks or commodities), traditional order books are generally illiquid and inefficient for trading contracts based on complex, high-dimensional, or purely informational outcomes like probability distributions. They do not inherently aggregate beliefs into a coherent probabilistic forecast.
- **Standard AMMs (e.g., Uniswap, Curve):** These are designed primarily for efficient swapping between existing tokenized assets, optimizing for price stability or low slippage based on token reserves.[36] Their invariants (e.g., constant product, stableswap) are not suited for representing and trading probability distributions over future events. While pm-AMM [8] adapts AMMs for prediction

markets, it focuses on binary outcomes and time-based dynamics.

- **Paradigm's Distribution Market (DM):** As analyzed in Section 2, Paradigm's model is constrained by the static backing parameter 'b'.[6] This limits its ability to represent highly peaked distributions, which are plausible in expert domains like AI model parameter prediction or scientific forecasting where strong consensus might emerge. The static nature of 'b' and the reliance on specific LP actions also make it less adaptable for long-term or highly dynamic markets like climate or economic forecasting compared to the potentially self-scaling nature of CDFM's (C_{total}).
- **LMSR-based Continuous Markets:** While LMSR provides a sound theoretical basis, adaptations for continuous outcomes face challenges. Discretization introduces approximation errors. The log-time interval market (LCMM) by Dudík et al. [27] offers computational efficiency and constant bounded loss, but still relies on pre-defined liquidity parameters ((b_k)) and lacks the dynamic, participant-funded nature of CDFM. Standard LMSR implementations can be computationally prohibitive for high resolution.[24] CDFM's participant-funded model offers a different approach to liquidity and scaling. The measure-theoretic approaches [31] provide theoretical grounding but practical, efficient implementations are still evolving.

Table 6.2.1: Comparative Suitability of Market Mechanisms for Continuous Outcome Applications

Application Domain	Key Requirement	Binary Market	Order Book	Paradigm DM	LMSR (LCMM)	CDFM (Proposed)
AI Model Uncertainty	Handle peaked distributions, expert input	Poor	Poor	Fair	Fair/Good	**Excellent**
Climate Variables	Long-term horizon, dynamic risk/liquidity	Poor	Poor	Fair	Good	**Excellent**
Economic Indicator	Full distributio	Poor	Poor	Good	Good	**Excellent**

s	n forecast, oracle integration					
Project Outcomes	Aggregate dispersed info, distribution shape	Poor	Fair	Good	Good	**Excellent**
Parametric Insurance Triggers	Price index distribution, hedging	Poor	Fair	Good	Good	**Excellent**

Justification Summary:

- *Binary/Order Book:* Fundamentally unsuited for distributional information.
- *Paradigm DM:* Limited by 'b' for peaks (AI) and static liquidity (Climate, Economics).
- *LMSR (LCMM):* Good theoretical properties, efficient computation, but relies on pre-set liquidity parameters ((b_k)), less dynamic than CDFM.
- *CDFM:* Participant funding allows dynamic scaling of depth/expressiveness potentially better suited for expert consensus (peaks in AI), long-term/dynamic risk (Climate), and aggregating dispersed information (Projects). Directly pricing index distributions (Parametric Triggers, Economics) is a core function.

6.3. Detailed Application Examples

We elaborate on three potential high-traction applications for the CDFM:

Example 1: Market on AI Model Parameter Distribution

- **Context:** Consider a large language model (LLM) being fine-tuned for a specific task (e.g., medical diagnosis summarization). A crucial aspect of understanding the model's behavior and potential biases might involve predicting the final distribution of values for a specific set of attention head weights or embedding vectors associated with sensitive concepts after fine-tuning. Experts (ML researchers, domain specialists) might have differing beliefs, possibly forming a strong consensus (a peaked distribution) around certain values based on prior experiments or theoretical understanding.[100]

- **Market Design:** A CDFM market is created over the continuous range of possible values for the target parameter (or a relevant summary statistic). Participants use a stablecoin (e.g., USDC) as collateral to trade the outcome function ($f(x)$), effectively betting on the probability density of the parameter's final value. The total collateral (C_{total}) reflects the market's aggregate conviction.
- **Why CDFM is Suitable:**
  - *Expressiveness:* If experts strongly agree on a narrow range, they can collectively contribute significant collateral (C_{total}), allowing the CDFM's ($f(x)$) to become highly peaked in that region, overcoming the ($\max f \le b$) limitation of Paradigm's model.[6]
  - *Participant Funding:* The market is funded by the experts themselves, aligning the market's depth with the conviction and capital commitment of those possessing relevant information. No external LP is needed.
  - *DMGT Integration:* Governance via staked DMGT could allow participants to tune risk parameters relevant to the rapid information flow and potential volatility in AI research domains.
- **Oracle:** Resolution requires a trusted and verifiable process to extract and report the true parameter value from the finalized model after the fine-tuning process is complete. This could involve cryptographic commitments or trusted third-party auditors.

Example 2: Market on Regional Climate Anomaly Distribution (Parametric Trigger Application)

- **Context:** Parametric insurance products are increasingly used to manage climate-related risks.[126] A policy might pay out if, for example, the average summer rainfall in a specific agricultural region falls below a certain threshold. The pricing and hedging of such contracts depend crucially on the perceived probability distribution of future rainfall.[127]
- **Market Design:** A CDFM market is established to trade the probability distribution of the cumulative rainfall (or deviation from average) over the relevant season (e.g., 0mm to 500mm range). Participants could include climate scientists, reinsurance companies, agricultural businesses, and speculators. They contribute collateral (e.g., USDC) to shape the market's function ($f(x)$).
- **Why CDFM is Suitable:**
  - *Distributional Output:* The market directly yields the consensus probability distribution for the underlying index, providing far richer information than a binary market on exceeding a single threshold. This distribution can be used directly for pricing various parametric contracts with different trigger points.
  - *Dynamic Adaptation:* Climate science and policy evolve. The

participant-funded nature allows (C_{total}) and market depth to adapt dynamically over the long term as new information emerges or participant interest changes, unlike a static 'b' model.[107]

- ○ *Hedging Tool:* Insurers or businesses exposed to rainfall risk can use the market to hedge their exposure by taking positions on ($f(x)$).
- **Oracle:** Resolution requires access to reliable, tamper-proof meteorological data for the specified region and period (e.g., from government weather services or trusted private providers).[126]

Example 3: Market on Project Completion Date Distribution

- **Context:** Estimating the completion date for complex projects, like large software developments or construction initiatives, is notoriously difficult. Traditional methods often yield single-point estimates (ETCs) that fail to capture the inherent uncertainty and potential for delays.[120] Project teams possess dispersed, often tacit, knowledge about risks, dependencies, and task durations.[122]
- **Market Design:** A CDFM market is created over a range of possible completion dates (e.g., discretized by week over the next 18 months). Participants are primarily the project team members, managers, and potentially key stakeholders. They might use internal "points," stablecoins, or even project-specific tokens as collateral to trade the outcome function ($f(x)$) representing the likelihood of completion in each week.
- **Why CDFM is Suitable:**
  - ○ *Uncertainty Representation:* The market naturally aggregates beliefs into a probability distribution over completion dates, explicitly showing the expected timeline, the variance (uncertainty), and any skewness (e.g., higher probability of delays than early finishes). This is more informative than a single ETC.[123]
  - ○ *Information Aggregation:* It provides a mechanism to surface and aggregate the private information and subjective assessments held by individual team members regarding task complexities and potential roadblocks.[121]
  - ○ *Participant Funding:* The total collateral (C_{total}) can serve as a proxy for the team's collective confidence or perceived risk level regarding the timeline.
- **Oracle:** Resolution is straightforward – the date the project is officially declared complete according to pre-defined criteria.

These examples illustrate how the CDFM's specific characteristics – participant funding, dynamic depth, and the ability to represent continuous distributions potentially including sharp peaks – make it particularly well-suited for applications involving expert judgment, long-term forecasting, complex system modeling, and risk

assessment where traditional market mechanisms are inadequate.

7. Implementation Considerations, Challenges, and Future Research

While the proposed Collateralized Distribution Function Market (CDFM) and its integrated DMGT token offer theoretical advantages, practical implementation faces significant technical and economic challenges. Addressing these is crucial for realizing the potential of this novel mechanism.

7.1. Technical Challenges

1. **Oracle Design for Continuous Outcomes:** A fundamental requirement for any prediction market is a reliable mechanism to determine the true outcome at resolution.[136] For continuous variables across diverse domains, this presents a substantial challenge:
   - *Data Source Integrity:* Identifying and accessing trusted, objective, and tamper-proof data sources for outcomes like AI model parameters, specific climate measurements (e.g., regional temperature anomalies, sea level), economic statistics, or project completion metrics is critical.[107]
   - *Manipulation Resistance:* Oracles must be resistant to manipulation by market participants or external actors who might have a vested interest in the market's outcome. Decentralized oracle networks (e.g., Chainlink [51]) or optimistic oracle systems with dispute resolution (like those used by UMA or Kleros [4]) are potential solutions, but their application to arbitrary continuous variables needs careful design and validation.
   - *Precision and Ambiguity:* The resolution process must handle the precision required for continuous outcomes and define clear rules for resolving ambiguity or data discrepancies.
2. **Computational Complexity and Efficiency:** The CDFM mechanism, particularly the calculation of the cost function ($\Delta C = C_{new} - C_{old}$) derived from the invariant ($\int V(f(x)) dx = R(C_{total})$), likely involves numerical integration. Performing such calculations efficiently and accurately within the constraints of blockchain environments (e.g., gas limits on Ethereum or L2s) is a major hurdle.[27]
   - *Approximation Techniques:* Practical implementations may require approximating the continuous function ($f(x)$) using techniques like piecewise polynomials, basis function expansions (splines, Fourier series), or discretization into a very large number of bins.
   - *Efficient Algorithms:* Leveraging data structures like the balanced binary trees used in log-time LMSR implementations [27] could be adapted if the function

representation allows for hierarchical decomposition.
- *Gas Optimization:* Smart contract code must be highly optimized to minimize computational overhead and transaction costs for users. Off-chain computation with on-chain verification might be necessary for complex calculations.

3. **Smart Contract Security:** The complexity of the CDFM mechanism, involving dynamic collateral management ((C_{total})) and potentially complex mathematical functions ((V, R)), increases the surface area for bugs and vulnerabilities.[41]
- *Mathematical Soundness:* Ensuring the chosen functions (V) and (R) and the payout logic are mathematically sound and cover all edge cases is paramount.
- *Exploit Prevention:* Preventing economic exploits, such as manipulating (C_{total}) or the pricing function, requires rigorous analysis and testing. Flash loan attacks or oracle manipulation could pose risks.
- *Auditing:* Thorough security audits by reputable firms specializing in complex DeFi protocols would be essential but potentially costly and time-consuming.

7.2. Economic Challenges

1. **Liquidity Bootstrapping:** A purely participant-funded model like CDFM faces a cold start problem. Without initial collateral ((C_{total})), the market has no depth, and prices might be extremely sensitive, deterring early traders.
- *Incentive Programs:* Initial liquidity could be incentivized through DMGT token rewards for early collateral providers or traders (participation mining).[90]
- *Hybrid Models:* An initial phase might involve a temporary, small backing amount (a mini-'b') provided by the protocol treasury or early investors, which is gradually phased out as participant collateral ((C_{total})) grows.
- *Market Focus:* Launching initially in domains with high intrinsic interest and knowledgeable participants (e.g., AI researchers betting on model parameters) might facilitate organic bootstrapping.

2. **Collateral Pool ((C_{total})) Volatility and Stability:** The dynamic nature of (C_{total}) is both a feature and a potential risk. Rapid decreases in (C_{total}) due to large withdrawals or net selling pressure could destabilize prices and reduce confidence in payout values, potentially leading to a death spiral similar to bank runs or DeFi protocol collapses.[10]
- *Risk Parameter Governance (DMGT Utility):* The governance function of DMGT becomes critical here. Stakers could vote on mechanisms to dampen volatility, such as:
  - Dynamic fees that increase during periods of high withdrawal pressure or

low ($C\_\{total\}$).
- Temporary withdrawal limits or time-locks triggered by rapid drops in ($C\_\{total\}$).
- Adjusting the ($R(C\_\{total\})$) function to make withdrawals less attractive when the pool is shrinking.
    - ○ *Monitoring and Transparency:* Real-time monitoring and clear visualization of ($C\_\{total\}$) and its impact on potential payouts are essential for participant confidence.

3. **Manipulation Resistance:** While participant funding aligns incentives differently, it doesn't eliminate manipulation risk. Whales (large capital holders) could potentially influence prices or ($C\_\{total\}$) dynamics, especially in thinly traded markets.[141] Attacks might target the pricing function during periods of low ($C\_\{total\}$) or attempt to trigger cascading withdrawals. Robust mechanism design and potentially dynamic parameter adjustments governed by DMGT are needed.[142]

4. **Parameter Sensitivity and Calibration:** The behavior of the CDFM heavily depends on the choice of the cost potential function (V) and the linking function (R). Selecting functions that provide desirable properties (incentive compatibility, appropriate price sensitivity, stable dynamics) requires careful theoretical analysis, simulation, and calibration. Poor choices could lead to market inefficiencies or instability.

7.3. Future Research Directions

The development of CDFM and similar participant-funded distribution markets opens several avenues for future research:

1. **Refining the CDFM Framework:** Explore alternative forms for the invariant, the cost potential function (V), and the linking function (R). Investigate functions that offer better trade-offs between expressiveness, stability, computational tractability, and incentive properties. Analyze the impact of risk aversion among participants.

2. **Advanced Tokenomics (DMGT):** Develop more sophisticated mechanisms for DMGT utility and value accrual. This could include dynamic staking rewards based on governance participation quality, integration with reputation systems, or more complex secondary token models (like MCT). Explore optimal vesting and emission schedules through modeling.[99]

3. **Empirical Validation:** Conduct extensive simulations to test the CDFM's behavior under various market conditions, participant strategies, and potential attacks. Run controlled laboratory experiments or pilot programs with real users to validate

theoretical properties and gather behavioral data.[143] Compare performance against alternative models like Paradigm's DM, LCMM [27], pm-AMM [8], or Bayesian market makers.[28]

4. **Multi-Dimensional Markets:** Extend the CDFM framework to handle multi-dimensional continuous outcomes (e.g., predicting the joint distribution of inflation and unemployment, or the spatial distribution of a climate variable). This introduces significant mathematical and computational complexity.

5. **Integration with AI Agents:** Explore the synergies between distribution markets and AI. AIs could act as sophisticated participants, leveraging their analytical capabilities to trade in CDFM markets, potentially improving market efficiency and accuracy, especially for complex or data-intensive domains.[105] Conversely, CDFM outputs could serve as valuable inputs for AI decision-making processes.

6. **Regulatory Landscape:** Analyze the evolving regulatory considerations for novel DeFi mechanisms like CDFM, particularly concerning collateral management, oracle reliance, and the nature of the traded instruments.[49]

Addressing these technical, economic, and research challenges will be crucial for moving participant-funded distribution markets from theoretical proposal to practical reality.

8. Conclusion

8.1. Summary of Contributions

This report has addressed the need for more expressive and capital-efficient mechanisms for trading on continuous probability distributions, motivated by the limitations of existing models, particularly the reliance of Paradigm's Distribution Markets on a large, static backing parameter 'b'.[6]

The primary contribution is the proposal and theoretical exploration of the **Collateralized Distribution Function Market (CDFM)**. This novel mechanism shifts the foundation of market liquidity and solvency away from external providers or static parameters towards a **participant-funded model**. The core idea is that the collective collateral (C_{total}) committed by traders dynamically backs the market's potential payouts and influences its depth and pricing. By linking an integrated cost function ($\int V(f(x)) dx$) to this dynamic collateral pool ($R(C_{total})$), the CDFM aims to:

- **Reduce reliance on 'b':** Eliminating the need for a large, static, externally provided backing parameter.
- **Enhance Expressiveness:** Potentially allowing for the representation of more peaked distributions (higher certainty) by scaling capacity with participant

conviction ((C_{total})).

- **Improve Capital Efficiency:** Utilizing actively risked trader capital as the direct backing for market payouts.
- **Introduce Dynamic Adaptation:** Enabling market depth to scale naturally with participation levels.

Secondly, the report detailed a sophisticated **native token integration strategy** for the **Distribution Market Governance & Utility Token (DMGT)**. Designed to meet specific constraints like avoiding simple trade fees while providing intrinsic value [User Query], the DMGT proposal centers on:

- **Staked Governance over Risk Parameters:** Granting staked DMGT holders control over crucial parameters governing the CDFM's stability and behavior, directly linking token utility to protocol function.[21]
- **Optional Staking Benefits:** Providing incentives like reduced mechanism costs or enhanced payouts for stakers, rewarding active participation without direct fees.[18]
- **Creative Utility (MCT):** Proposing the tokenization of market certainty/risk as a secondary token, further embedding utility within the protocol's core information aggregation role.[20]
- **Sustainable Economics:** Incorporating standard practices for developer allocation (2% vested) [44] and emphasizing broad community distribution to foster network effects.[39]

Finally, the report identified and justified **high-traction application domains** where the CDFM offers potential advantages over existing market types. These include forecasting distributions for AI model parameters, climate variables, economic indicators, complex project outcomes, and pricing parametric insurance triggers.[100] The analysis highlighted how CDFM's specific features align with the requirements of these domains, particularly the need for distributional information, handling of expert consensus (peaks), and dynamic adaptation.

8.2. Potential Impact

The development and successful implementation of mechanisms like the CDFM, coupled with well-designed tokenomics like DMGT, could have a significant impact on several fields:

- **Evolution of Prediction Markets:** Moving beyond binary and simple scalar markets towards truly continuous distributional forecasting can unlock richer information aggregation, providing nuanced insights into collective beliefs and uncertainty across science, economics, finance, and technology.[2]
- **DeFi Innovation:** The participant-funded model offers a potential paradigm shift

in AMM design, prioritizing capital efficiency and dynamic scaling driven by user

Works cited

1. Designing Markets For Prediction - Harvard DASH, accessed on April 10, 2025, https://dash.harvard.edu/bitstreams/7312037c-910d-6bd4-e053-0100007fdf3b/download
2. What is a Prediction Market? - OSL, accessed on April 10, 2025, https://osl.com/academy/article/what-is-a-prediction-market
3. Prediction Market: Overview, Types, Examples - Investopedia, accessed on April 10, 2025, https://www.investopedia.com/terms/p/prediction-market.asp
4. Prediction Markets Explained - LessWrong, accessed on April 10, 2025, https://www.lesswrong.com/posts/GxmfqKjs6ruxNxhqr/prediction-markets-explained
5. Prediction Markets: Theory and Applications - Harvard DASH, accessed on April 10, 2025, https://dash.harvard.edu/server/api/core/bitstreams/9f4daf73-e061-4262-90fc-54d11b1e11c7/content
6. Distribution Markets - Paradigm, accessed on April 10, 2025, https://www.paradigm.xyz/2024/12/distribution-markets
7. The Gates Hillman prediction market - CMU School of Computer Science, accessed on April 10, 2025, https://www.cs.cmu.edu/~sandholm/Gates-Hillman%20prediction%20market.RevEconDesign13.pdf
8. pm-AMM: A Uniform AMM for Prediction Markets - Paradigm, accessed on April 10, 2025, https://www.paradigm.xyz/2024/11/pm-amm
9. Ultimate Guide to Automated Market Makers (AMMs) in DeFi 2024 - Rapid Innovation, accessed on April 10, 2025, https://www.rapidinnovation.io/post/amm-types-differentiations
10. How Liquidations Work in DeFi: A Deep Dive - MixBytes, accessed on April 10, 2025, https://mixbytes.io/blog/how-liquidations-work-in-defi-a-deep-dive
11. Why DeFi lending? Evidence from Aave V2 - Bank for International Settlements, accessed on April 10, 2025, https://www.bis.org/publ/work1183.pdf
12. THE RISE, FALL, AND LEGACY OF THE STRUCTURE-CONDUCT-PERFORMANCE PARADIGM | Journal of the History of Economic Thought | Cambridge Core, accessed on April 10, 2025, https://www.cambridge.org/core/journals/journal-of-the-history-of-economic-thought/article/rise-fall-and-legacy-of-the-structureconductperformance-paradigm/3BA4E9F9FE29BAED06E9F1860BD37052
13. Beyond the SCP paradigm: Merger control for the twenty-first century - Hausfeld, accessed on April 10, 2025, https://www.hausfeld.com/en-us/what-we-think/competition-bulletin/beyond-the-scp-paradigm-merger-control-for-the-twenty-first-century/
14. Information and the Change in the Paradigm in Economics - Columbia Business School, accessed on April 10, 2025,

https://business.columbia.edu/sites/default/files-efs/imce-uploads/Joseph_Stiglitz/2002_Info_and_Change_in%20Paradigm.pdf

15. How a New Distribution Paradigm Changes the Core Resources, Competences and Capabilities Endowment: The Case of Mobile Application Stores - ResearchGate, accessed on April 10, 2025, https://www.researchgate.net/publication/224149522_How_a_New_Distribution_Paradigm_Changes_the_Core_Resources_Competences_and_Capabilities_Endowment_The_Case_of_Mobile_Application_Stores

16. Towards a Paradigm Shift in Economics? - Books & ideas, accessed on April 10, 2025, https://booksandideas.net/Towards-a-Paradigm-Shift-in,1974

17. Paradigm Shifts in Economic Theory and Policy - Intereconomics, accessed on April 10, 2025, https://www.intereconomics.eu/contents/year/2018/number/3/article/paradigm-shifts-in-economic-theory-and-policy.html

18. Token pricing: A guide | Stripe, accessed on April 10, 2025, https://stripe.com/en-jp/resources/more/token-pricing-how-it-works-and-how-to-make-the-most-of-it

19. Token Utility: Use Cases & Trends | by Rabia Fatima | Medium, accessed on April 10, 2025, https://medium.com/@rabiafatima/token-utility-use-cases-trends-742cd9b08faa

20. DeFi Asset Tokenization: Revolutionizing Finance with Blockchain Technology, accessed on April 10, 2025, https://www.rapidinnovation.io/post/defi-asset-tokenization-use-cases-benefits-challenges

21. Understanding Token Valuation: What It Is and When You Need It - Eqvista, accessed on April 10, 2025, https://eqvista.com/company-valuation/valuation-crypto-assets/token-valuation/

22. Understanding Token Velocity - Multicoin Capital, accessed on April 10, 2025, https://multicoin.capital/2017/12/08/understanding-token-velocity/

23. HANSON'S AUTOMATED MARKET MAKER, accessed on April 10, 2025, https://www.ubplj.org/index.php/jpm/article/download/451/489/1429

24. How does the Logarithmic Market Scoring Rule (LMSR) work? - Cultivate Labs | Collective intelligence solutions using crowdsourced forecasting, accessed on April 10, 2025, https://www.cultivatelabs.com/crowdsourced-forecasting-guide/how-does-logarithmic-market-scoring-rule-lmsr-work

25. A Practical Liquidity-Sensitive Automated Market Maker | Request PDF - ResearchGate, accessed on April 10, 2025, https://www.researchgate.net/publication/311463948_A_Practical_Liquidity-Sensitive_Automated_Market_Maker

26. Automated Market Makers That Enable New Settings: Extending Constant-Utility Cost Functions - ResearchGate, accessed on April 10, 2025, https://www.researchgate.net/publication/266347090_Automated_Market_Makers_That_Enable_New_Settings_Extending_Constant-Utility_Cost_Functions

27. www.ifaamas.org, accessed on April 10, 2025,

https://www.ifaamas.org/Proceedings/aamas2021/pdfs/p465.pdf

28. A Bayesian Market Maker - People, accessed on April 10, 2025, https://people.cs.vt.edu/~sanmay/papers/bmm-ec.pdf

29. A Practical Liquidity-Sensitive Automated Market Maker - Computer Science, accessed on April 10, 2025, http://www.eecs.harvard.edu/cs286r/courses/fall12/papers/OPRS10.pdf

30. Abraham Othman's research works | University of Pennsylvania and other places, accessed on April 10, 2025, https://www.researchgate.net/scientific-contributions/Abraham-Othman-7016791717

31. projects.iq.harvard.edu, accessed on April 10, 2025, https://projects.iq.harvard.edu/sites/projects.iq.harvard.edu/files/yiling/files/measures.pdf

32. [PDF] Information aggregation in exponential family markets - Semantic Scholar, accessed on April 10, 2025, https://www.semanticscholar.org/paper/Information-aggregation-in-exponential-family-Abernethy-Kutty/0b5da467f5c9ad23aff1f7681ad4201f0bc49177

33. aaaimarketstutorial [licensed for non-commercial use only] / FrontPage, accessed on April 10, 2025, http://aaaimarketstutorial.pbworks.com/

34. Profit-Charging Market Makers with Bounded Loss, Vanishing Bid/Ask Spreads, and Unlimited Market Depth, accessed on April 10, 2025, https://www.cs.cmu.edu/~sandholm/profitChargingMarketMaker.ec12.pdf

35. [PDF] Log-time Prediction Markets for Interval Securities | Semantic Scholar, accessed on April 10, 2025, https://www.semanticscholar.org/paper/Log-time-Prediction-Markets-for-Interval-Securities-Dud%C3%ADk-Wang/ac18880d3f0102d34364aaddc28711be20ec688c

36. What Are Automated Market Makers (AMMs) & AMM Types | The Luxury Playbook, accessed on April 10, 2025, https://theluxuryplaybook.com/what-are-automated-market-makers-amms-amm-types/

37. Top 15 DeFi Protocols: The Future of Finance Unveiled - Debut Infotech, accessed on April 10, 2025, https://www.debutinfotech.com/blog/top-defi-protocols

38. Enhancing the macroprudential dimension of Solvency II - European Systemic Risk Board, accessed on April 10, 2025, https://www.esrb.europa.eu/pub/pdf/reports/esrb.200226_enhancingmacroprudentialdimensionsolvency2~1264e30795.en.pdf

39. Tokenomics 101: Building Sustainable Economic Models - Forbes, accessed on April 10, 2025, https://www.forbes.com/councils/forbesbusinessdevelopmentcouncil/2024/12/12/tokenomics-101-building-sustainable-economic-models/

40. What is Tokenomics: The Key to Sustainable Crypto Ecosystems | Tokonomo Academy, accessed on April 10, 2025, https://academy.tokonomo.com/defi/what-is-tokenomics/

41. How to Design a Sustainable Tokenomics Model in a Defi Project? - Nextrope -

Your Trusted Partner for Blockchain Development and Advisory Services, accessed on April 10, 2025, https://nextrope.com/how-to-design-a-sustainable-tokenomics-model-in-a-defi-project/

42. Tokenomics, the economic framework that governs decentralized finance (DeFi), is poised to... | by SevenHash | Medium, accessed on April 10, 2025, https://medium.com/@sevenhash/tokenomics-in-defi-powering-the-future-of-decentralized-finance-2cc645bad1c2

43. Tokenomics |The Ultimate Guide to Crypto Economy Design - Rapid Innovation, accessed on April 10, 2025, https://www.rapidinnovation.io/post/tokenomics-guide-mastering-blockchain-token-economics-2024

44. Funding PoW Cryptocurrency. Donations, Premine, Mining, and... | by Hoosat Network | Mar, 2025 | Medium, accessed on April 10, 2025, https://medium.com/@toni.lukkaroinen/funding-pow-cryptocurrency-3fafe701684e

45. Token distribution and fundraising models: an overview - Blog, accessed on April 10, 2025, https://blog.bcas.io/token-distribution-and-fundraising-models

46. Understanding Token Value and Cryptoeconomics: A Deep Dive - Byte Federal, accessed on April 10, 2025, https://www.bytefederal.com/byteu/14/163

47. What is Tokenomics? - Complete Guide for Investors, accessed on April 10, 2025, https://www.tokenmetrics.com/blog/tokenomics

48. Tokenomics: A Beginner's Guide to Crypto Investing - tastycrypto, accessed on April 10, 2025, https://www.tastycrypto.com/blog/tokenomics-a-beginners-guide-to-crypto-investing/

49. DeFi and Regulation - The Tokenizer, accessed on April 10, 2025, https://thetokenizer.io/2024/11/22/defi-and-regulation/

50. Tokenization Meaning: Definition, Pros, Cons, and More - BitDegree, accessed on April 10, 2025, https://www.bitdegree.org/crypto/tutorials/tokenization-meaning

51. The Insider's Guide to Understanding Utility Tokens - Morpher, accessed on April 10, 2025, https://www.morpher.com/blog/utility-tokens

52. MakerDAO and the Future of Decentralized Stablecoins | by Bryson Ballew | Oregon Blockchain Group | Medium, accessed on April 10, 2025, https://medium.com/oregon-blockchain-group/makerdao-and-the-future-of-decentralized-stablecoins-8260c6578b38

53. MakerDAO (MKR) Tokenomics and Roadmap - Pintu Academy, accessed on April 10, 2025, https://pintu.co.id/en/academy/post/maker-tokenomics

54. Introduction to Tokenomics: Explaining Crypto Token Economic Models Beyond Supply and Demand | by Blockchain Today | Coinmonks | Medium, accessed on April 10, 2025, https://medium.com/coinmonks/introduction-to-tokenomics-explaining-crypto-token-economic-models-beyond-supply-and-demand-4a0601ba2d31

55. A closer look at the ve(3,3) tokenomics model in DeFi | OAK Research, accessed on April 10, 2025,

https://oakresearch.io/en/analyses/fundamentals/a-closer-look-at-ve33-tokenomics-defi

56. Subtles nuances with great consequences: a cross analysis of Curve and Velodrome, accessed on April 10, 2025, https://tokenbrice.xyz/crv-vs-velo/

57. Curve Finance and veCRV Tokenomics - Nansen Research Portal, accessed on April 10, 2025, https://research.nansen.ai/articles/curve-finance-and-vecrv-tokenomics

58. Tokenomics Fundamentals Part IV: Token supply & demand dynamics - inWeb3, accessed on April 10, 2025, https://www.inweb3.com/tokenomics-fundamentals-part-iv-token-supply-demand/

59. veCRV-ve(3,3)-veNFT. Curve has been at the top of the… - iZUMi Finance, accessed on April 10, 2025, https://izumi-finance.medium.com/vecrv-ve-3-3-venft-e3a4e6330649

60. esGMX + veCRV Gauges = esGS. The long awaited deep dive into… | by DeFi Devin | GammaSwap Labs | Medium, accessed on April 10, 2025, https://medium.com/gammaswap-labs/esgmx-vecrv-gauges-esgs-70fd496805e1

61. Vote Escrow: Boosting On-chain Accountability and Transparency - Cardano Spot, accessed on April 10, 2025, https://cardanospot.io/news/vote-escrow-boosting-on-chain-accountability-and-transparency-zcTx7t9KkzhBu3kM

62. What Is Vote Escrow? - CoinMarketCap, accessed on April 10, 2025, https://coinmarketcap.com/academy/article/what-is-vote-escrow

63. [2311.17589] Emergent Outcomes of the veToken Model - arXiv, accessed on April 10, 2025, https://arxiv.org/abs/2311.17589

64. To 've' or not to 've' – What are veTokens? - Wintermute, accessed on April 10, 2025, https://wintermute.com/to-ve-or-not-to-ve-what-are-vetokens

65. Synthetix (SNX) Price, Charts & News - Coinmetro, accessed on April 10, 2025, https://www.coinmetro.com/price/snx

66. What is Synthetix? (SNX) - Bitstamp, accessed on April 10, 2025, https://www.bitstamp.net/en-gb/learn/cryptocurrency-guide/what-is-synthetix-snx/

67. How to stake Synthetix Network (SNX) - KoinX, accessed on April 10, 2025, https://www.koinx.com/staking-guides/how-to-stake-synthetix-network

68. Synthetix SNX Staking & sUSD Minting Tutorial - Milk Road, accessed on April 10, 2025, https://milkroad.com/snx-staking-tutorial/

69. Principles of Incentive Designing in Web3 That You Should Know - BlockSurvey, accessed on April 10, 2025, https://blocksurvey.io/learn-tokenomics/incentive-design-web3

70. 15 Best Utility Tokens to Consider in 2025 (Updated List) - HeLa, accessed on April 10, 2025, https://helalabs.com/blog/15-best-utility-tokens-to-consider-in-2024-updated-list/

71. Explainer: Utility vs. Security Tokens - Crypto Council for Innovation, accessed on

April 10, 2025,
https://cryptoforinnovation.org/utility-tokens-security-tokens-blockchain-digital-assets-tokens-ownership-regulations-crypto-defi/

72. Security Tokens vs. Utility Tokens : A Concise Guide - Blockchain Council, accessed on April 10, 2025,
https://www.blockchain-council.org/blockchain/security-tokens-vs-utility-tokens-guide/

73. What is Synthetix Network Token? - SNX - Exponential DeFi, accessed on April 10, 2025,
https://exponential.fi/assets/synthetix-network-token/682ca79b-b029-4949-a59e-82e96b6d6f70

74. Tokenomics in Crypto: How to Effectively Calculate and Understand Burn Rates - BlockApps, accessed on April 10, 2025,
https://blockapps.net/blog/tokenomics-in-crypto-how-to-effectively-calculate-and-understand-burn-rates/

75. MKR crypto: Tokens underpinning the MakerDAO ecosystem | CoinLoan Blog, accessed on April 10, 2025,
https://coinloan.io/blog/mkr-crypto-tokens-underpinning-makerdao/

76. What is a coin burn? - Defi Pulse Blog, accessed on April 10, 2025,
https://www.defipulse.com/blog/coin-burn

77. Evaluating MKR's Tokenomics. The Buyback and Burn model changes… | by David Hoffman | POV Crypto | Medium, accessed on April 10, 2025,
https://medium.com/pov-crypto/evaluating-mkr-def6d36092bd

78. Crypto Liquidity Provider Tokens (LP Tokens) - DeFi - Gemini, accessed on April 10, 2025,
https://www.gemini.com/cryptopedia/liquidity-pool-crypto-exchange-liquidity-provider-lp-token

79. A Brief Guide on Crypto Liquidity Pools - SoluLab, accessed on April 10, 2025,
https://www.solulab.com/a-brief-guide-on-crypto-liquidity-pools/

80. A data-driven look at the state of DeFi - CryptoSlate, accessed on April 10, 2025,
https://cryptoslate.com/a-data-driven-look-at-the-state-of-defi/

81. What is asset tokenization? - Hedera, accessed on April 10, 2025,
https://hedera.com/learning/tokens/what-is-asset-tokenization

82. Asset Tokenization Explained: Benefits, Risks, and How It Can Work - Chainalysis, accessed on April 10, 2025,
https://www.chainalysis.com/blog/asset-tokenization-explained/

83. DeFi asset tokenization: Unlocking new possibilities - LeewayHertz, accessed on April 10, 2025, https://www.leewayhertz.com/defi-asset-tokenization/

84. What is Asset Tokenization: Why & Why Now? | Avalanche Blog, accessed on April 10, 2025,
https://www.avax.network/blog/what-is-asset-tokenization-why-why-now

85. What is Tokenization - Types, Use Cases, and Implementation - Debut Infotech, accessed on April 10, 2025, https://www.debutinfotech.com/what-is-tokenization

86. Asset Tokenization: Digital Assets Explained - Chainlink, accessed on April 10, 2025, https://chain.link/education/asset-tokenization

87. Assessing the Benefits and Challenges of Tokenizing Real World Assets, accessed on April 10, 2025, https://www.braumillerlaw.com/assessing-the-benefits-and-challenges-of-tokenizing-world-assets/

88. An In-Depth Guide to DeFi Asset Tokenization | by James Alexa | Medium, accessed on April 10, 2025, https://medium.com/@jamesalexa0001/an-in-depth-guide-to-defi-asset-tokenization-1de4defac1c5

89. Tokenomics: How to make better crypto investments [2025] - Blockpit, accessed on April 10, 2025, https://www.blockpit.io/en-us/blog/tokenomics

90. Incentive Structures in Tokenomics | BrightNode, accessed on April 10, 2025, https://brightnode.io/blog-articles-blockchain-web3-insights/incentive-structures-in-tokenomics

91. Fair Launch Crypto: A Comprehensive Guide - Bitbond, accessed on April 10, 2025, https://www.bitbond.com/resources/fair-launch-crypto-a-comprehensive-guide/

92. Explained: What Is a Fair Launch Crypto? - OSL, accessed on April 10, 2025, https://osl.com/academy/article/explained-what-is-a-fair-launch-crypto/

93. Premine - Decred Documentation, accessed on April 10, 2025, https://docs.decred.org/advanced/premine/

94. Maker - A Deep Dive Into The World's First Unbiased Global Financial System, accessed on April 10, 2025, https://www.artemis.xyz/research/maker---a-deep-dive-into-the-worlds-first-unbiased-global-financial-system

95. The Role of Pre-Mining in Crypto Projects - Nadcab Labs, accessed on April 10, 2025, https://www.nadcab.com/blog/pre-mining-in-blockchain

96. Understanding Tokenomics in Crypto: A Guide to DeFi Yield Farming - BlockApps Inc., accessed on April 10, 2025, https://blockapps.net/blog/understanding-tokenomics-in-crypto-a-guide-to-defi-yield-farming/

97. Tokenomics and incentive mechanisms in the cryptoverse - UEEx Technology, accessed on April 10, 2025, https://blog.ueex.com/tokenomics-in-the-cryptoverse-ueex/

98. Synthetix Price Prediction 2024: How is SNX Responding to Coinbase Perpetuals Launch?, accessed on April 10, 2025, https://www.ccn.com/analysis/synthetix-snx-price-prediction/

99. (PDF) Designing a Token Economy: Incentives, Governance, and Tokenomics, accessed on April 10, 2025, https://www.researchgate.net/publication/390271393_Designing_a_Token_Economy_Incentives_Governance_and_Tokenomics

100. Why Businesses Need AI Forecasting for Better Planning - 180ops, accessed on April 10, 2025, https://www.180ops.com/blog/why-businesses-need-ai-forecasting-for-better-planning

101. AI-Based Demand Forecasting: Improving Prediction Accuracy and Efficiency

- Netguru, accessed on April 10, 2025,
https://www.netguru.com/blog/ai-based-demand-forecasting

102. 5 Must-Know AI Forecast Stats to Boost Marketing ROI, accessed on April 10, 2025,
https://www.numberanalytics.com/blog/must-know-ai-forecast-stats-marketing-roi

103. AI Sales Forecasting for B2B: Increase Forecast Accuracy by AI - Forecastio, accessed on April 10, 2025, https://forecastio.ai/blog/ai-sales-forecasting

104. AI forecasting: Techniques, Benefits & How it works? - Zoho, accessed on April 10, 2025, https://www.zoho.com/analytics/glossary/ai-forecasting.html

105. How AI Transforms Market Predictions Across Industries - IdeaSoft.io, accessed on April 10, 2025, https://ideasoft.io/blog/ai-agents-prediction-markets/

106. Everything about AI Forecasting Models - Cogent Infotech, accessed on April 10, 2025,
https://www.cogentinfo.com/resources/everything-about-ai-forecasting-models

107. Why I Left Breakthrough to Work on Climate Prediction Markets, accessed on April 10, 2025,
https://thebreakthrough.org/issues/energy/why-i-left-breakthrough-to-work-on-climate-prediction-markets

108. LONG-TERM PREDICTION MARKETS, accessed on April 10, 2025,
https://www.ubplj.org/index.php/jpm/article/download/592/631/1835

109. Joint-outcome prediction markets for climate risks - PMC, accessed on April 10, 2025, https://pmc.ncbi.nlm.nih.gov/articles/PMC11364416/

110. Joint-outcome prediction markets for climate risks | PLOS One, accessed on April 10, 2025,
https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0309164

111. A Prediction Market for Climate Outcomes - Scholarship Repository, accessed on April 10, 2025,
https://ir.law.fsu.edu/cgi/viewcontent.cgi?article=1505&context=articles

112. Climate Change Regulation and Prediction Markets | Cato Institute, accessed on April 10, 2025,
https://www.cato.org/regulation/summer-2014/climate-change-regulation-prediction-markets

113. Economic Forecasts and Projections: Fact Sheet | Congress.gov, accessed on April 10, 2025, https://www.congress.gov/crs-product/R47295

114. Economic Forecasting for Distribution Companies in the USA: Navigating Uncertainty in 2025 - LaceUp Solutions, accessed on April 10, 2025,
https://www.laceupsolutions.com/economic-forecasting-for-distribution-companies-in-the-usa-navigating-uncertainty-in-2025/

115. Economic Forecasts and Projections: Fact Sheet - CRS Reports, accessed on April 10, 2025, https://crsreports.congress.gov/product/pdf/R/R47295

116. Economic Indicators That Help Predict Market Trends - Investopedia, accessed on April 10, 2025,
https://www.investopedia.com/articles/economics/08/leading-economic-indicators.asp

117. Economic Data Forecasting & Modeling - Moody's, accessed on April 10, 2025, https://www.moodys.com/web/en/us/capabilities/economic-data.html

118. Economic Indicators & Forecasts | S&P Global, accessed on April 10, 2025, https://www.spglobal.com/market-intelligence/en/solutions/economic-indicators-forecasts

119. Modeling the distribution of key economic indicators in a data-rich environment: new empirical evidence - Taylor and Francis, accessed on April 10, 2025, https://www.tandfonline.com/doi/full/10.1080/01605682.2025.2457645?af=R

120. The Top 7 Forecasting Models For Project Managers - BestOutcome, accessed on April 10, 2025, https://bestoutcome.com/knowledge-centre/forecasting-models/

121. Project Forecasting: The Ultimate Guide for Successful Project Management - SixSigma.us, accessed on April 10, 2025, https://www.6sigma.us/project-management/project-forecasting/

122. What Is Project Forecasting in Project Management?, accessed on April 10, 2025, https://ppm.express/blog/project-forecasting/

123. Task Completion: Completion Forecasting: Predicting Project Timelines - FasterCapital, accessed on April 10, 2025, https://fastercapital.com/content/Task-Completion--Completion-Forecasting--Predicting-Project-Timelines.html

124. ETC or ETA? Estimated Time of Completion in Project Management - Motion, accessed on April 10, 2025, https://www.usemotion.com/blog/estimated-time-of-completion

125. Predictive Project Management: Enhance Efficiency | TrueProject, accessed on April 10, 2025, https://www.trueprojectinsight.com/blog/project-office/predictive-project-management

126. Parametric Insurance Market to hit USD 40 Bn by 2033, North America 35% share, holding USD 5.5 Bn revenue. - EIN Presswire, accessed on April 10, 2025, https://www.einpresswire.com/article/779961691/parametric-insurance-market-to-hit-usd-40-bn-by-2033-north-america-35-share-holding-usd-5-5-bn-revenue

127. Parametric Insurance Market Size & Share, Growth Analysis 2034, accessed on April 10, 2025, https://www.gminsights.com/industry-analysis/parametric-insurance-market

128. Parametric Insurance Market Size & Share | Growth Trends 2037, accessed on April 10, 2025, https://www.researchnester.com/reports/parametric-insurance-market/6467

129. Parametric Insurance Market Size, Share | CAGR of 9%, accessed on April 10, 2025, https://market.us/report/parametric-insurance-market/

130. Parametric Insurance Market Set for Significant Growth: Projections to 2032 - Captive.com, accessed on April 10, 2025, https://www.captive.com/news/parametric-insurance-market-set-for-significant-growth-projections-to-2032

131. Parametric Insurance: A Complement to Traditional Property Coverage - Aon, accessed on April 10, 2025,

https://www.aon.com/en/insights/articles/parametric-insurance-a-complement-to-traditional-property-coverage

132. Parametric Insurance Trends on the Horizon Against Climate & Emerging Risks, accessed on April 10, 2025, https://descartesunderwriting.com/insights/parametric-insurance-trends-an-alternative-insurance

133. ELI5: What is Futarchy?. Submitted for Superteam UK Scribe... | by Sekar Langit | Medium, accessed on April 10, 2025, https://medium.com/@sekarl/eli5-what-is-futarchy-ba2978d5d91b

134. amoveo-docs/blog_posts/futarchys_failure.md at master - GitHub, accessed on April 10, 2025, https://github.com/zack-bitcoin/amoveo-docs/blob/master/blog_posts/futarchys_failure.md

135. Prediction Markets in The Corporate Setting - Samotsvety Forecasting, accessed on April 10, 2025, https://samotsvety.org/blog/2021/12/31/prediction-markets-in-the-corporate-setting/

136. Introduction to DeFi Prediction Markets - Blaize Tech, accessed on April 10, 2025, https://blaize.tech/blog/how-defi-prediction-markets-work-exploring-blockchain-based-forecasting-platforms/

137. The Polymarket Crypto Prediction Market - Gemini, accessed on April 10, 2025, https://www.gemini.com/cryptopedia/polymarket-prediction-markets-crypto-decentralized-betting

138. What Is an Automated Market Maker (AMM)? - Gemini, accessed on April 10, 2025, https://www.gemini.com/cryptopedia/amm-what-are-automated-market-makers

139. What is an Automated Market Maker (AMM)? AMMs explained - MoonPay, accessed on April 10, 2025, https://www.moonpay.com/learn/defi/what-is-an-automated-market-maker-amm

140. Seer: Crafting Smarter Prediction Markets for a Complex World - Kleros, accessed on April 10, 2025, https://blog.kleros.io/seer-crafting-smarter-prediction-markets-for-a-complex-world/

141. Polymarket - Wikipedia, accessed on April 10, 2025, https://en.wikipedia.org/wiki/Polymarket

142. Token Economics & Incentive Design - 10XTS, accessed on April 10, 2025, https://10xts.com/services/token-economics-incentive-design/

143. Walk this Way! Incentive Structures of Different Token Designs for Blockchain-Based Applications - AIS eLibrary, accessed on April 10, 2025, https://aisel.aisnet.org/cgi/viewcontent.cgi?article=1547&context=icis2019

144. From prediction markets to info finance, accessed on April 10, 2025, https://vitalik.eth.limo/general/2024/11/09/infofinance.html